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ABSTRACT

Economics and energy are topics of interest to students and teachers alike. They both affect our daily lives, influence how we live and have significant impacts on how our children will live. Since economic education was mandated by the Florida legislature, many attempts have been made to integrate the free enterprise and consumer education objectives with the traditional content of the social studies curriculum. "Solar Economics: A Teacher's Guide" is a collection of instructional units (lessons) built around the state objectives using solar energy as a unifying theme. Objectives, materials needed, list of student activities and student handouts, worksheets, and/or readings are provided for each lesson. A list of free enterprise and consumer education objectives and a paper on solar energy in Florida are provided in appendices. Lesson topics include: competition; solar workers; labor force; consumer goods; energy scarcity/choice; energy resources; substitution; alternatives/substitutions in production; production factors; economics of small wind machines; technological progress; solar demand; supply/demand; consumer math; price/cost; comparison shopping; using Energy Guide labels for comparison shopping; shade trees as investments; solar investments; solar insurance; examining warranties; tax credits; government regulation; rational consumer behavior; comparing solar collectors; and how laws can affect a decision to make investment. (Author/JN)

SOLAR ECONOMICS:

A Teacher's Guide

Edited by:
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and
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SOLAR ECONOMICS: A TEACHERS GUIDE

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September 1982

FOREWORD

Economics and energy are topics of interest to students and teachers alike. They both affect our daily lives, influence how we live and have significant impacts on how our children will live. Since economic education was mandated by the Florida legislature, many attempts have been made to integrate the free enterprise and consumer education objectives with the traditional content of the social studies curriculum. SOLAR ECONOMICS: A Teacher's Guide, is a collection of instructional units built around the state objectives using solar energy as a unifying theme. Not all the objectives are covered. Teachers can modify the units to include the additional objectives if they wish to do so.

This Guide is not intended to be a directory of solar technology. There is an abundance of references on the various aspects of solar energy applications. Our intention is to show teachers (and their students) that some technologies are cost effective now and economics is a useful tool to compare them with conventional energy sources. Much of the material in this Guide came from SOLAR ENERGY AND THE FINANCIAL COMMUNITY and copies are available from the Florida Solar Energy Center. The Florida Solar Energy Center has an abundance of materials that are very useful to teachers. Some of these are reproduced in this book; others may be obtained by writing the Center.

We hope you enjoy using these materials and will provide us with feedback and suggestions for additional units. Please duplicate any of the information contained in this book and use it with your classes.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

1. COMPETITION

OBJECTIVES: A. 5. Define competition as the effort of two or more parties to secure the business of a third party.

A. 6. Describe some ways in which competition benefits the consumer.

MATERIALS: Solar equipment advertisements.

ACTIVITIES:

1. Ask students what it means "To compete."

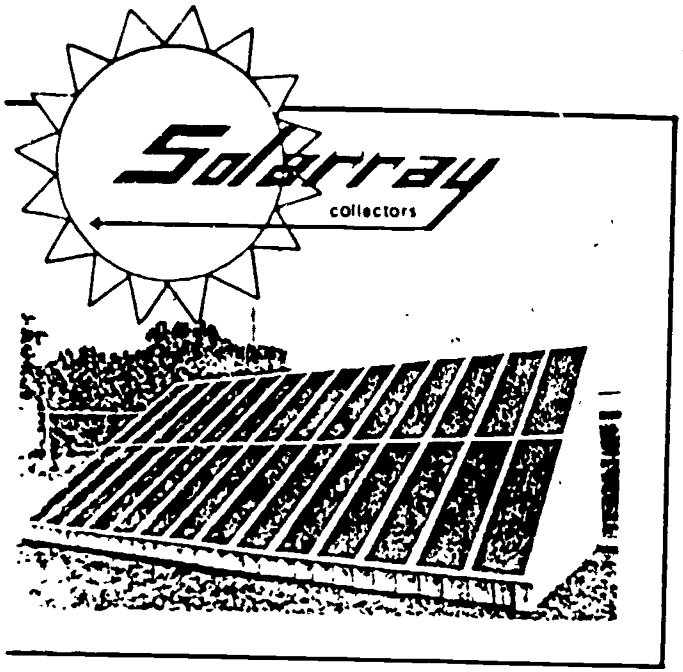
2. Ask them to list examples of competition in school settings.

3. Select one or more examples and ask them to list the advantages and disadvantages of such competition.

4. Tell them that our free enterprise system is based upon competition. Ask them to give examples and to list the advantages and disadvantages of such a competitive system.

5. Using their knowledge and feelings about competition, ask them to study the solar equipment advertisement and explain its purpose and characteristics...in light of our competitive free enterprise system.

6. With students (and their parents?) list the benefits of solar energy as a competitive energy source, and of competition among producers of solar equipment in America.



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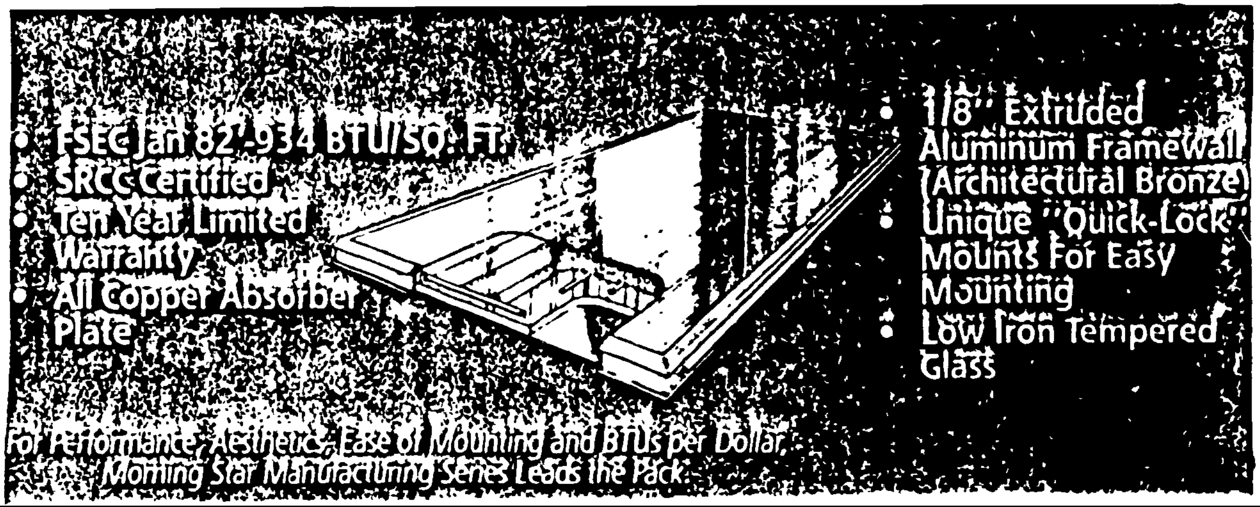

2. SOLAR WORKERS

OBJECTIVE: C. 10. Define labor force as people employed or seeking employment.

MATERIALS: Student Handout: Employment

ACTIVITIES:

1. Ask students to jot down the meaning of the following terms:
   WORK WORKER LABOR LABORER EMPLOYMENT FORCE
   Discuss these terms with the students to get common meanings. Stress labor and labor force.

2. Discuss the importance of the labor force in any economic activity. Detail some of the features of a quality work force: for example, education and training, attitude toward work, skills, numbers of workers available in an area, etc.

3. Ask students to read the handout on Employment. Discuss the needs for a labor force in solar energy in Florida. What are the kinds of workers needed. How can we get such workers trained and ready?

4. Call or write the vocational education center, community college, and university in your area for information on training for solar energy jobs.

STUDENT HANDOUT

SOLAR EMPLOYMENT

The major energy-producing and energy-using industries of the U.S. consume one-third of this nation's energy but provide only 10 percent of the nation's jobs. Capital investment per employee in petroleum and public utility industries is $108,000 and $105,500 respectively--three times the average capital investment per job in other industries.

"Many analysts argue that energy growth is crucial to a reduction in employment. In reality, the purpose of what we commonly call 'energy' is to reduce the need for human labor, exacerbating the problem of providing jobs for a growing labor force. Industry has increased its ouptut by drawing on the apparently limitless supplies of fossil fuels while shrinking its labor force. As the Congressional Office of Technology Assessment has commented, 'the national energy pol cy of the last several decades has been to replace human labor as rapidly as possible with petroleum energy.' Thus the same practices which are creating the energy shortage have also been responsible for the shortage of jobs." The above quote was taken from Leon Rodberg's Employment Impact of the Solar Transition, which was prepared for the Joint Economic Committee, U.S. Congress, 1979.

In contrast, the application of solar energy is labor-intensive; a transition to solar energy from nonrenewable fossil fuels should produce an increase in employment.

Demand for qualified mechanics and technicians in the re-emerging solar industry is already developing and, at current growth trends, may soon create a serious manpower shortage. Government, industry and labor organizations foresee a potential shortage of skilled solar installers necessary for President Carter's projection of 2.5 million solar installations by 1985. FSEC estimates that there are 43,000 solar system existing in Florida--11,000 of them installed in 1979 alone. Solar installations in Florida could exceed 300,000 by 1985 and 2 million by the year 2000, given proper incentives.

A 40 percent increase within a decade in the number of solar energy scientists, engineers and technicians was projected in 1976 by the Energy Research and Development Administration However, many in the solar field believe that the projection was too conservative. The rise in the number of practitioners ... paralleled the dramatic rise during the last two years in the number of ... earchers.

A MITRE Co... tion study predicted a $10 billion applied solar energy industry by the late 1980s. It is anticipated that most of the jobs created by the solar industry's growth will relate to construction and conversion rather than research. The training required for these jobs is expected to be short term and/or a modification of existing programs. However, it would be erroneous to assume that the existing trades will shift from conventional heating and cooling applications without some degree of formal training in the technology.

"In an era where the private corporate economy seems incapable of creating sufficient employment, responsibility for job creation increasingly falls to be public decisions. In this context, a significant advantage accrues to any energy source that can claim that it is essential to increasing employment."

3. LABOR FORCE

OBJECTIVE: C. 10. Define labor force as people employed or seeking employment.

MATERIALS: None

ACTIVITIES:

1. Have students research the solar industry and products produced.

   a. Kinds of manufactured products

   b. Locations of manufacturers, addresses

   c. Location of distributors

2. Have students write to manufacturers using a list of prepared questions. Have students list questions to be answered. Samples:

   a. What are the materials used to manufacture your product?

   b. Describe the processes through which these materials become your product.

   c. How many people are involved in each manufacturing process? Total number of people employed?

   d. What skills are needed by these employees engaged in each process?

   e. Is your company hiring new employees?

   f. Do you find applicants for positions trained or educated for the required tasks?

   g. If not, do you have a training program??

   h. How do you predict your work force needs?

   i. Get production history and project estimates of future production.

   How are products distributed?

   k. When (if ever) are you overstocked?

   l. Why? Ramification?

3. If there are local distributors for the products, have students visit the distributor and determine:

a. Amount of sales in past year

b. Projected sales

c. Compare information from manufacturers and distributors as to projected future sales.

d. Have students pretend to be customers (consumers) and have a salesman give his sales talk.

e. Have students discuss and evaluate sales talk.

f. Find out how many people are employed in selling this product/these products.

g. What skills are necessary.

h. Get employment history of present salesmen. Were they previously in related work or were trained to do this work?

4. Evaluation: Divide class into groups.

   1. Manufacturers (select a student to represent a plant supervisor who has responsibility for products).

      a. Have at least one person to represent one employee engaged in each one of the manufacturing processes.

      b. Have each student explain his job.

   2. Distributors (select a student to act as distributor).

      a. Have at least one person to act as salesman.

      b. Have at least one person to act as deliveryman.

      c. Have at least one person to act as repairman.

5. Have students prepare and role play the manufacturing and distribution process.

4. CONSUMER GOODS

OBJECTIVE: Define consumer goods as items that are capable of satisfying a human want.

MATERIALS: Window Treatment for Energy Conservation, by R. McCluney

ACTIVITIES:

1. Consumer goods are items made to be purchased by consumers - anyone with buying power. These items are for personal needs: clothing, food, shelter.

2. ... and personal wants ... other possessions that a consumer decides to pay money for: boat, car, pets, television, air conditioning, window awnings.

3. Research definition of consumer goods in related text.

4. Windows are built into our homes (our shelter) as a standard accessory today. Yet they are not always placed on a wall with ultimate cooling, heating, ventilation and illumination in mind. Read "Window Treatment for Energy Conservation."

5. Given the definition of consumer goods and the handout "Window Treatment for Energy Conservation," the student will sketch his/her home... plot north, east, south, and west on the sketch...trace the sun's path over the home during a weekend day...analyze the window's placement... determine whether the purchase of awnings, window film, exterior roll blinds, or shutters (as consumer goods) would satisfy the human want of comfort inside the home.

Window Treatment for Energy Conservation

by W.R. McCluney

The purpose of this Energy Note is to give the non-technical reader a clear look at windows—how to get the most from them in cooling, heating, ventilating and illuminating the home. Although most of the points are applicable anywhere in the country, emphasis is on summer solar heat gain experienced in buildings in the Sun Belt, especially in Florida.

Two very common features of southern open living style are large window areas to let the light and breezes in, and shading devices or window films to keep the hot sunshine out. While we do not delve into window sizing, because it relates only to new construction or remodelling, we do have something to say about design guidelines and strategies. Much attention is given to shading devices and window films, as they represent feasible steps for existing buildings.

In winter, windows should seal tightly and allow the sun to enter the building without glare but prevent heat loss to the outside by conduction. For the warmer seasons they would be operable to let breezes in, they should keep solar heat out while still allowing light for illumination.

One window for all reasons and seasons is hardly a practical expectation. Large windowed openings for maximum view and solar illumination of the interior might be nice on a summer day, but so would small ones to minimize heat gain in a building. In winter, large but well-insulated openings facing the sun provide both illumination and direct solar heating with a minimum of glare. But at night these openings should be sealed and insulated tightly if they are to prevent heat escape.

Thus, the best one can have will be a compromise combination of these competing features. It is possible to design a wonder window complete with continuously adjustable shutters or louvers, reflective films, exterior shading devices, and removable insulating plugs that would meet all the above requirements. Such a window would, in principle, save considerable energy and perform well. It would, in fact, cost a lot of money and demand a bit of maintenance.

Window Design Guidelines

Following are same Florida window design guidelines for optimum cooling, heating, ventilating and illumination:

1. To minimize infiltration energy losses in winter and summer, and to maximize ventilation control at other times, all windows should be openable, with easy-to-operate mechanisms for controlling airflow. When closed, they should seal tightly—a feature often lacking in jalousie windows.
2. Double-pane windows with an insulating air space sealed tightly between the panes of glass or plastic resist conductive heat transfer. (In the relatively mild Florida climate, well-insulated and sealed single-pane windows may be adequate, especially if heating and air conditioning are seldom used.) Window frames should be made of poor heat conducting material such as wood or plastic. If made of metal (a good heat conductor) they should contain "thermal breaks." These are insulating sections built into the window frame to block heat conduction through it (Figure 1). When window shopping, always ask about frame design. Have the salesman show you how his window minimizes conductive heat transfer with dual panes and thermal breaks. Make sure that the window seals tightly when closed.
   Sliding glass doors rival jalousies' inability to seal tightly, and they often lack thermal breaks.

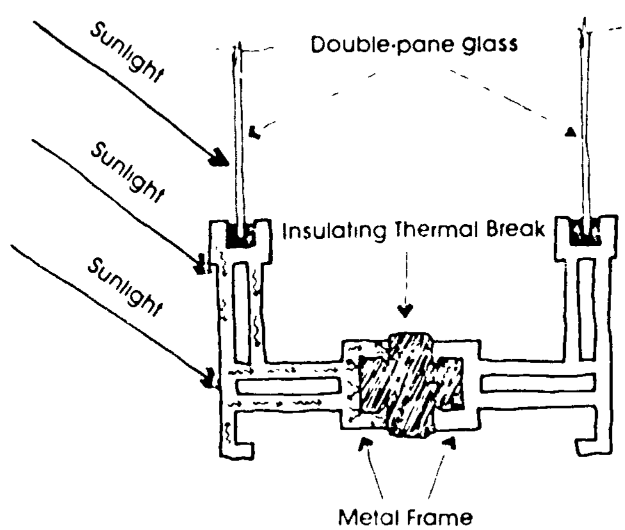

Figure 1
Window frame section showing thermal breaks.

3. Figure 2 shows that the sun is much higher overhead at noon in the summer than in the winter, also that it rises and sets north of east and north of west in summer, and south of east and south of west in winter. These sun paths are important to design and placement of windows and shading devices.

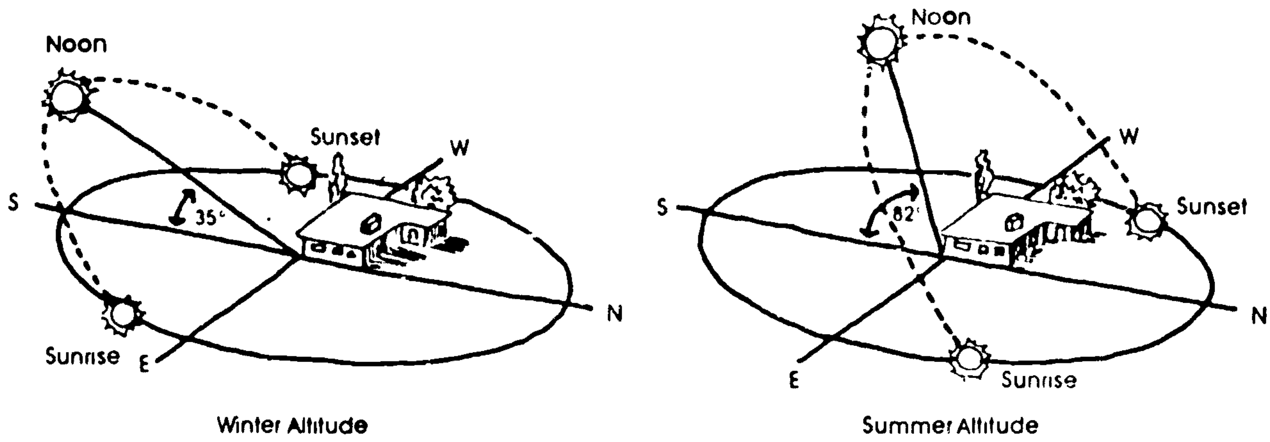

Figure 2
Sun path diagrams.

Window Design Strategies

1 A southern window exposure with proper roof overhang (Figure 3) provides shade from the hot midday summer sun but lets solar heat enter in winter. (Roof overhang design for southern, eastern and western exposures is contained in Florida Solar Energy Center Design Notes, **Concepts in Passive Design #1 and #2,** by Philip W. Fairey
2 A northern window exposure provides excellent, and cool, illumination. The small amounts of direct sunshine reaching these windows from the early morning and late afternoon summer sun comes at such an angle that very little heat enters the building Judicious use of northern window exposure is particularly suited to southern Florida's brief heating season and lengthy cooling season.
3 Windows facing east or west (or south without adequate roof overhangs) demand some exterior shading for proper energy management—from trees, shrubs or trellis vines that tend to lose their leaves in winter, or from awnings or shutters

Retrofit Options

Much can be done to minimize energy costs when designing a building from scratch, but options for existing buildings are more limited Thus, with windows and sliding glass doors which are poorly oriented or lack adequate overhangs the problem grows

Replacement or repair of poor energy performing windows is an obvious first step Permanently closed windows should be replaced with operable ones, jalousies should be replaced with better-sealing units, thought should be given to double-pane windows if much space conditioning is used, and caulking can do wonders to stop air leaks through some window frame designs Storm windows and doors also greatly increase efficiency

Although a shading device eflects a lot of sunshine, it also absorbs a lot of it and gets hot, thus, a shading device's purpose is partially defeated if it is indoors.

Among the many types of exterior shading devices are louvered insect screens which allow a view of the outside yet block direct sunshine, and metal or canvas awnings (Figure 4) Some canvas awnings can be rolled up and down as required Exterior shading vanes or louvers permanently fixed in place in the building facade are common in the tropics

Roll blinds, generally of hollow or insulation-filled slat construction, can have small spaces between the slats to allow some filtered sunlight to enter the window They are available in motorized or hand-operated models (operated from the inside) (Figure 5)

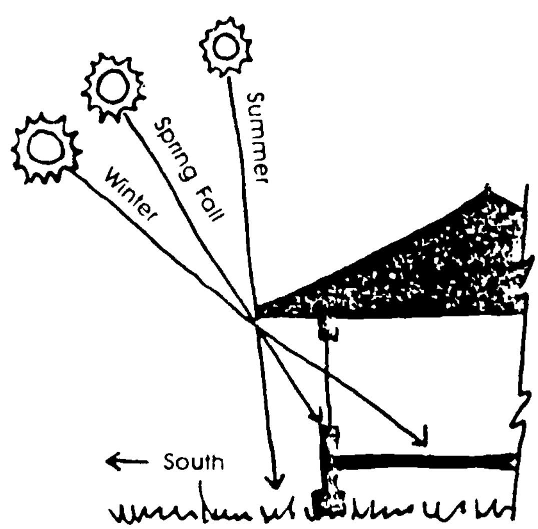

Figure 3
Seasonal shading performance of south-facing roof overhangs.

Window shutters abound—the Sarasota, the Bahamo (or Bimini), the split, side-hinged type; and the side-sliding shutter (Figure 6) All can be effective.

The publication **Windows for Energy Efficient Buildings**, Vol 1, Nos 1 and 2, is chock full of information of all kinds of window products and is available from Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, CA 94720

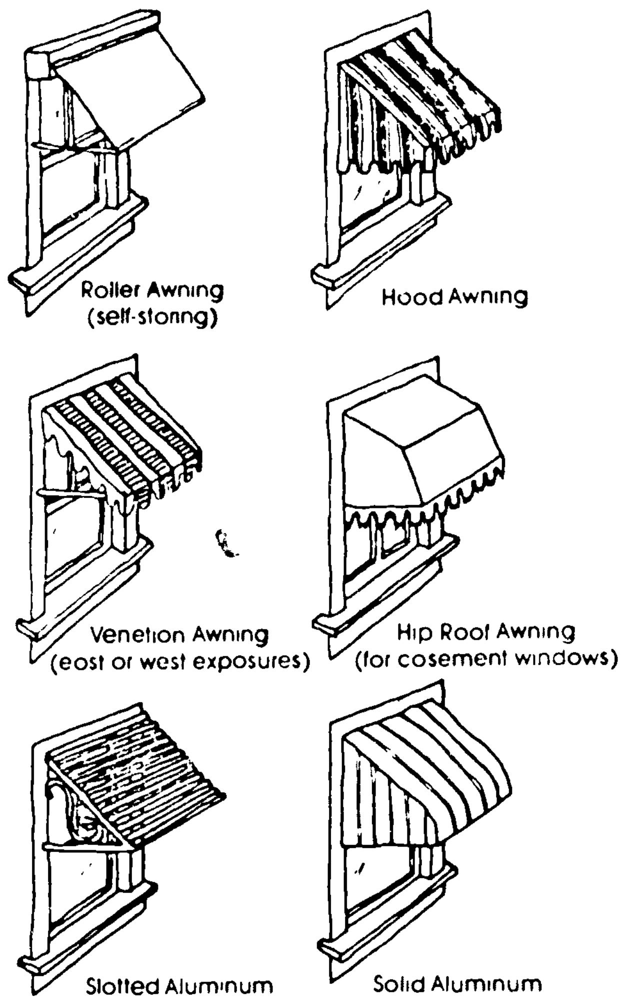

Figure 4
Types of awnings.

Window Films

Exterior shading devices are preferable to window films (or coatings) for reducing heat gain because they prevent direct sunshine from reaching the window pane in the first place A properly designed shade should be able to block all direct rays from the sun but still admit enough indirect and diffuse light for illumination Since film typically reduces heat gain, smaller windows might be preferable to film from a heat standpoint, but the cost of replacing the sun-facing windows in a building could be prohibitive, which scores another point for exterior shading

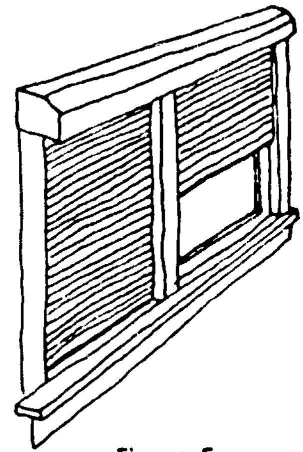

Figure 5
Exterior roll blind. Horizontal slats are encased in an edge frame. Blind rolls up into enclosure at top of window by motor or interior hand operation.

However, there may be times when window film is desirable, for aesthetic, architectural, or economic reasons Slightly tinted window films can effectively reduce the glare resulting from excessive window brightness (Properly designed exterior shades can accomplish the same purpose with better overall energy performance) Most films are less expensive than many of the recommended exterior shading devices When a new type of spectrally-selective film becomes available (which selects more of the sun's light and less of its heat for transmission), the above criticisms can be relaxed This new film, when it performs well, is expected to transmit nearly twice as much light as it does heat

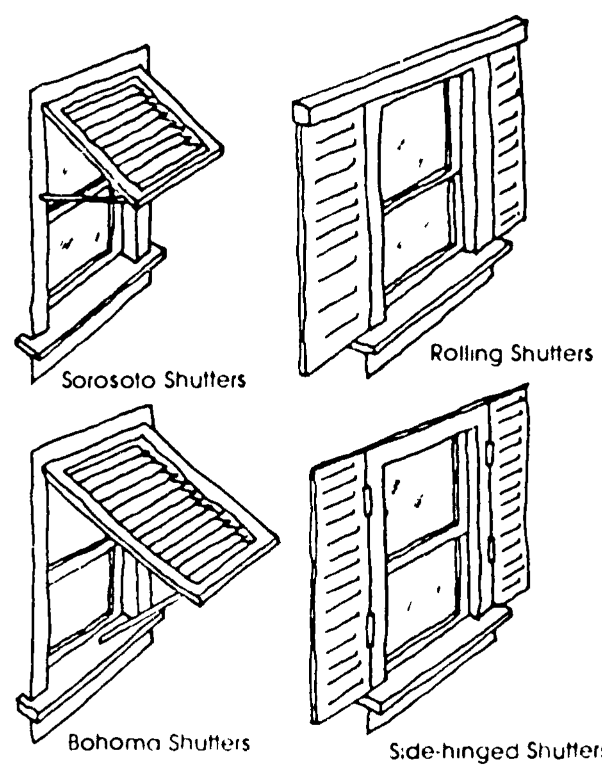

Figure 6
Types of shutters.

It is difficult to design a direct contact window film that can withstand being repeatedly taken off and put back on to suit the season, but a solution to the seasonal problem is now available from several manufacturers (Ref 8). This product is a sort of interior storm window for use in warm climates. It seals tightly against the inside of the regular window, trapping an insulating "dead air" space in between. The summer version could be coated with a reflective material, hopefully spectrally selective. The winter version should be highly transparent to admit maximum light and heat into the building but still provide the insulating advantage of a double-pane window. In the ventilating season, the interior storm window would be removed. These devices offer a very cost-effective alternative to replacing jalousie windows.

Summary

In general, exterior shading devices do the best job of protecting windows from direct sunshine. As an alternative, window films can reduce the summer air conditioning load. The reflective type of film is superior to the absorptive, and the new spectrally-selective films should be better than both of those. For the best energy control, film should be used only in the summer, when air conditioning is needed.

Film is most effective when applied to the outside of the window; however, exposure to the elements causes rapid deterioration. Interior installation, usually recommended by manufacturers, does not significantly affect film's relative performance.

(Editor's Note. Mr. Fairey's Design Notes on roof overhangs, **Concepts In Passive Design #1 and #2,** are available free of charge from the Florida Solar Energy Center, 300 State Road 401, Cape Canaveral, FL 32920.)

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5. ENERGY SCARCITY AND CHOICE

OBJECTIVES: D. 14. Identify why scarcity requires choices.

K. 49. Define consumers as users of goods and services.

MATERIALS: Student Handout: Decision-Making

ACTIVITIES:

1. The world's supply of fossil fuels--coal, oil, gas is strictly limited. If current consumption patterns continue, shortages and exhaustion of supply will occur within students' lifetimes. Hopes for discoveries of new fossil fuel deposits of sufficient magnitude to alter these statements are false hopes. Alternative energy sources are already nearly fully exploited, involve energy and environmental trade-offs which would themselves demand significant changes in human life systems, or assume improbable technological breakthroughs. Ask students to explain why the "energy crisis" is a material of scarcity or shortage in supply.

2. Liken the shortage of declining fossil resources and their rising costs, ask students to read the handout "Decision Making." Discuss the choices--and the probability of self-interested decisions by the public (choice number 7).
   For most people, five provides more satisfaction than four and seven provides more satisfaction than six. Regardless of what others may do, the individual's rational decision would be to use energy uncaringly. Since the same logic applies to most people, the likely outcome is conclusion five: continued heavy energy use and the rapid onset of a real crisis.

   This kind of decision situtation has been recognized as widespread in human social affairs and has been called The Prisoners' Dilemma (based on the work of Dr. Ben Gorman, University of Florida, Gainesville). In this "game," players who act selfishly will always "win" (receive greater satisfactions or goods) compared to participants who make altruistic decisions. The net effect will almost invariably be that most players act selfishly, and the whole group or system is worse off than if all had acted altruistically.

   This logic can only be short-circuited by changes in the considerations, or structure of the game. In this particular case, the most plausible alteration involves rewriting consideration three. That is, government or some other institution (not the individual decision makers) must force contingencies on individuals for heavy consumption.

   In policy terms, attempts to influence citizen behavior and consumer's decisions will be more effective if they restructure the cost benefit factors implicated in these decisions, rather than attempting to manipulate the logic of the decision process. Specifically, instead of brainwashing people to regulate their thermostats, change the tax and charge structure of fuel so that thermostat regulation becomes a selfishly sensible choice, or re-engineer thermostats so that there is no individual choice.

3. Have students work out a simple plan, which preserves human freedom, but "changes the game" to promote conserving behavior.

STUDENT HANDOUT

DECISION MAKING

GENERAL CONSIDERATION 1. If heavy consumption causes an energy crisis, the material quality of life will be severly degraded.

GENERAL CONSIDERATION 2. If conservation of energy is generally practiced, the material quality of life can be sustained with fairly high satisfaction levels for everyone.

GENERAL CONSIDERATION 3. Heavy individual consumption provides high personal satisfactions in the individual's material quality of life beyond the general satisfaction level.

STRATEGIC CONCLUSION 4 If conservation is generally practiced, and if I also conserve, then I will enjoy average satisfaction.

STRATEGIC CONCLUSION 5. If conservation is generally practiced, and if I consume heavily, then I will enjoy the average high satisfactions of consideration two, above, plus the individual bonus satisfactions in consideration three.

STRATEGIC CONCLUSION 6. If widespread heavy consumption occurs, and if I practice conservation, then I will suffer the same loss of satisfaction as everyone else, according to consideration one.

STRATEGIC CONCLUSION 7. If widespread heavy consumption occurs, and if I am also a heavy consumer, then I will suffer the same loss of satisfactions as everyone else (consideration one). In the meanwhile I will have enjoyed the higher individual satisfactions (consideration three).

Read each "general consideration" laying out the context of our situation. Then, decide on the <u>one</u> "strategic conclusion" you would choose to follow. Be prepared to discuss your <u>reasons</u>.

6. ENERGY RESOURCES

OBJECTIVES: D. 15. Identify energy resources.

D. 22. Identify how energy factors affect the cost and availability of goods and services.

MATERIALS: Student Handout 1: Present & Future Energy Sources
Student Handout 2: Energy in Florida
Student Handout 3: Energy Scenario in Florida
Student Handout 4: U.S. Energy Consumption

ACTIVITIES:

1. Take common objects in the classroom which are being "consumed." Ask what energy was used to get it from raw materials to product in the classroom. (See Energy To Burn, 16 mm film available in film libraries). Samples:

   a. Melvin's leather shoe; b. Sally's pad of paper; c. Carlos' steel lunch box; d. Juanita's plastic beads...

2. Ask students how education might be different if the cost of energy doubled or tripled tomorrow (e.g., energy costs in raw materials, transportation, manufacturing, higher costs = higher salaries needed = higher taxes? and so forth).

3. Ask them what would happen to the cost of Melvin's shoe, Sally's paper, Carlos' lunch and lunch box, etc.

4. Review the sources of energy discussed in Student Handouts 1, 2, and 4. Review the consumption of energy by sector. What are the differences between Florida and the United States? Explain the differences.

5. How will foreign oil embargos affect Florida? the United States? Review Handout 3. How do rapidly rising prices of energy affect the cost of goods and services? Why does this happen?

6. Design a plan of action for Florida to relieve these problems... Explain your plan of action.

STUDENT HANDOUT 1

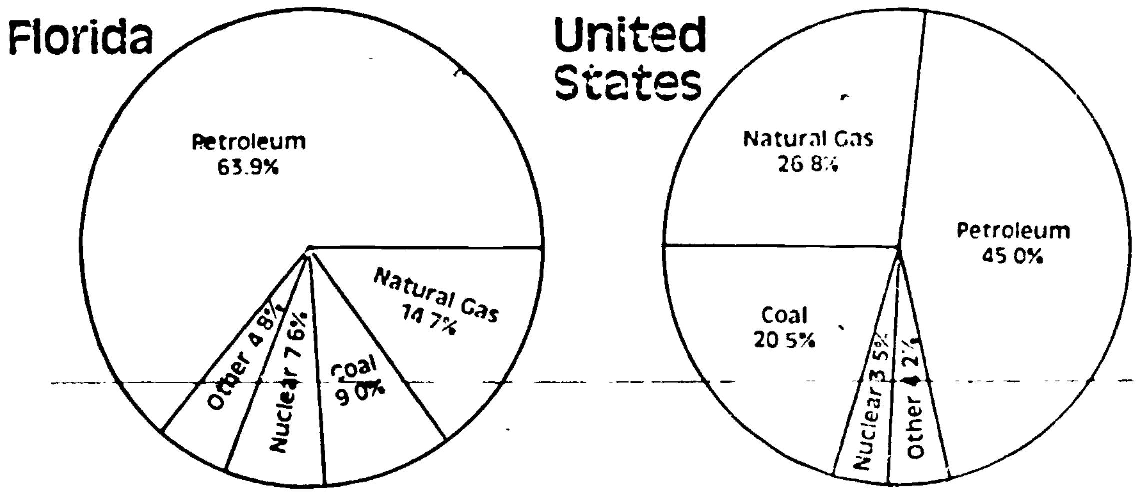
PRESENT AND FUTURE ENERGY SOURCES

ENERGY SOURCE		DEVELOPMENT STATUS AND PROSPECTS FOR FUTURE USE*
FOSSIL FUELS	Petroleum	Now widely used. Domestic production @ 9 million barrels per day (mbd), due to increase to 10 mbd; currently import @ 8.4 mdb. Enhanced recovery methods now in use. Supplies limited. Possibly depleted in 30 to 40 years.
	Natural Gas	Now widely used. U.S. consumption of 20 trillion cubic feet per year; 95 percent produced domestically, small imports from Canada and Mexico. Construction of new pipeline from Alaska likely. A non-renewable resource. Such promising synthetic gas technologies as coal-derived gas, though not currently used, appear to offer increasing energy source.
	Coal	Use increasing. Some difficulty in extracting. U.S. has an estimated 27 percent of world's coal resources. Distribution system weak. Some environmental problems. Slated to replace oil for electrical generation. Effort in progress to produce synthetic fuels from coal.
NUCLEAR		Now in limited use. Fissionable fuel is limited. Currently 12 percent of U.S. electrical supply provided by nuclear. Reactor orders have declined in past years. Radioactive waste storage, transportation, and disposal are long-term problems for this industry.
GEOTHERMAL		Now in limited use. Exploration continues for suitable sites. Future development thought to be limited.
SOLAR ENERGY	Hydro-electric	Now in use. Provides 4 to 5 percent of total U.S. electrical power for Pacific Northwest. Incentives for small-scale (low-head) hydro are now in progress. Number of sites for future development is limited.
	Wind	Now in limited use. Many demonstration projects functioning.
	Heating and Cooling	Now in use, growth rate dramatic particularly for domestic hot water systems. Commercial uses growing. Both active and passive systems have unlimited fuel supply. Initial costs greater than those for conventional heating systems.

Photovoltaics (Solar Cells)	Direct conversion of sunlight to electricity. In limited use. Cost-effective in limited remote applications. Costs have been reduced dramatically but not enough to compete with current electrical costs.
Biomass	Energy produced from plant matter. In limited use. Wood burning increasing in all areas of the country. In the last year, 2.5 million wood stoves have been sold in the United States. R&D effort in pyrolysis (decomposition of organic matter by heating), biophotolysis (simulating photosynthesis), and fermentation among other processes is being supported.
Ocean Thermal Energy Conversion (OTEC)	Energy derived from ocean temperature differentials. Now in experimental stages.
Solar Thermal Electric Systems	Steam-generating plant using concentrators (heliostats) to boil water in a central power tower. Now in experimental stages.
Solar Satellites	Satellites with large photovoltaic arrays, which would beam electricity to earth via microwaves. Now in conceptual stages.

Student Handout 2: Energy In Florida.

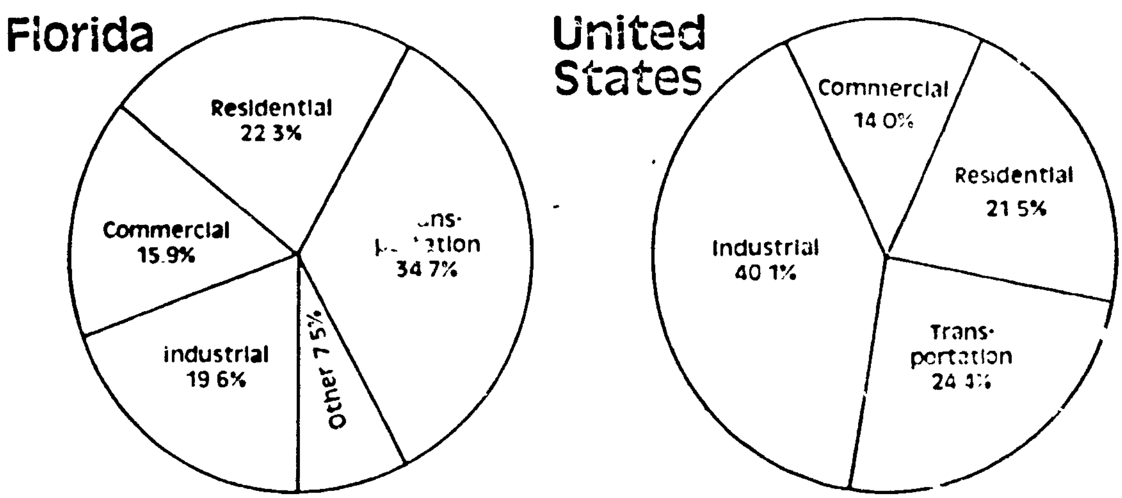
Percentage of Total Energy Consumption by Primary Energy Type — 1980



In 1980, the State depended on petroleum and natural gas for almost 80 percent of its energy needs. petroleum constituted 63 9 percent of the total consumption of primary energy This contrasted with the United States as a whole, which used petroleum and natural gas for approximately 69 percent of its energy needs, with only 45 percent of primary energy consumption being petroleum.

Total Consumption	Florida	2,459.3 trillion Btu
	U.S.	76,270.0 trillion Btu

Percentage of Total Energy Consumption by Sector — 1980



The consumption of energy in Florida differs from that of the country as a whole. The transportation sector is the largest energy consuming sector in the State. In 1980, transportation accounted for 34 7 percent of energy use in Florida, but only 24 4 percent of the nation's. While over 40 percent of the country's total energy consumption was in the industrial sector, industry accounted for less than 20 percent of energy use in Florida

STUDENT HANDOUT 3

ENERGY SCENARIO IN FLORIDA

The end of the '70s saw the end of an era of cheap and abundant energy. John Searingen, chairman of Standard Oil of Indiana has warned that "with the advent of the 1980s, we enter an era of high energy prices, tight energy supplies, and chronic world wide shortages."

The nation's conventional and alternative energy sources are limited. Florida's energy problem is more acute because the state has an energy-intensive economy without significant fossil fuel resources.

Florida's energy supply is critically dependent on foreign oil and the stability of the international oil market. Fossil fuels are becoming scarce. The only constant in today's energy picture is the rising price of every major source of energy.

World oil production probably will peak between 1985 and 2000; oil production in the United States reached its peak in 1970. Based on estimates of fossil fuel resources within the state, Florida could support its own energy demands for less than one year.

The 1973 oil embargo brought with it the first realization that supply difficulties lay ahead. Yet, our economy today is still based on these depleting resources. Oil and gas, the two fuels which are in shortest supply, provide 85 percent of Florida's energy needs. These fuels are most likely to experience the sharpest price increases. Few states, other than producing ones, have as high a degree of petroleum dependency as Florida.

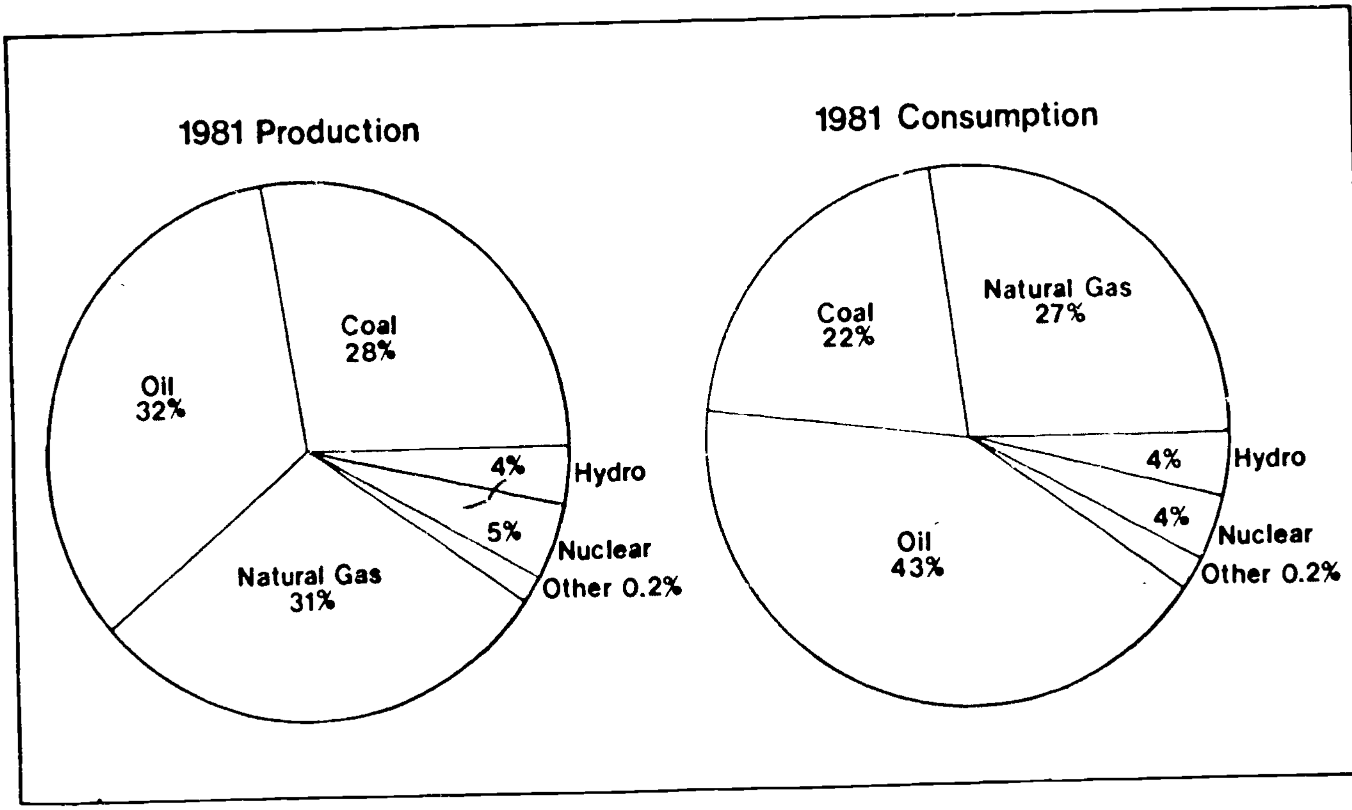
Forecasts of energy consumption in Florida show our petroleum dependency increasing through 1990. Electricity consumption in Florida has been doubling approximately every eight years. If this continues, Floridians will increase consumption of electricity in the next eight years by as much as it has increased since the advent of electricity.

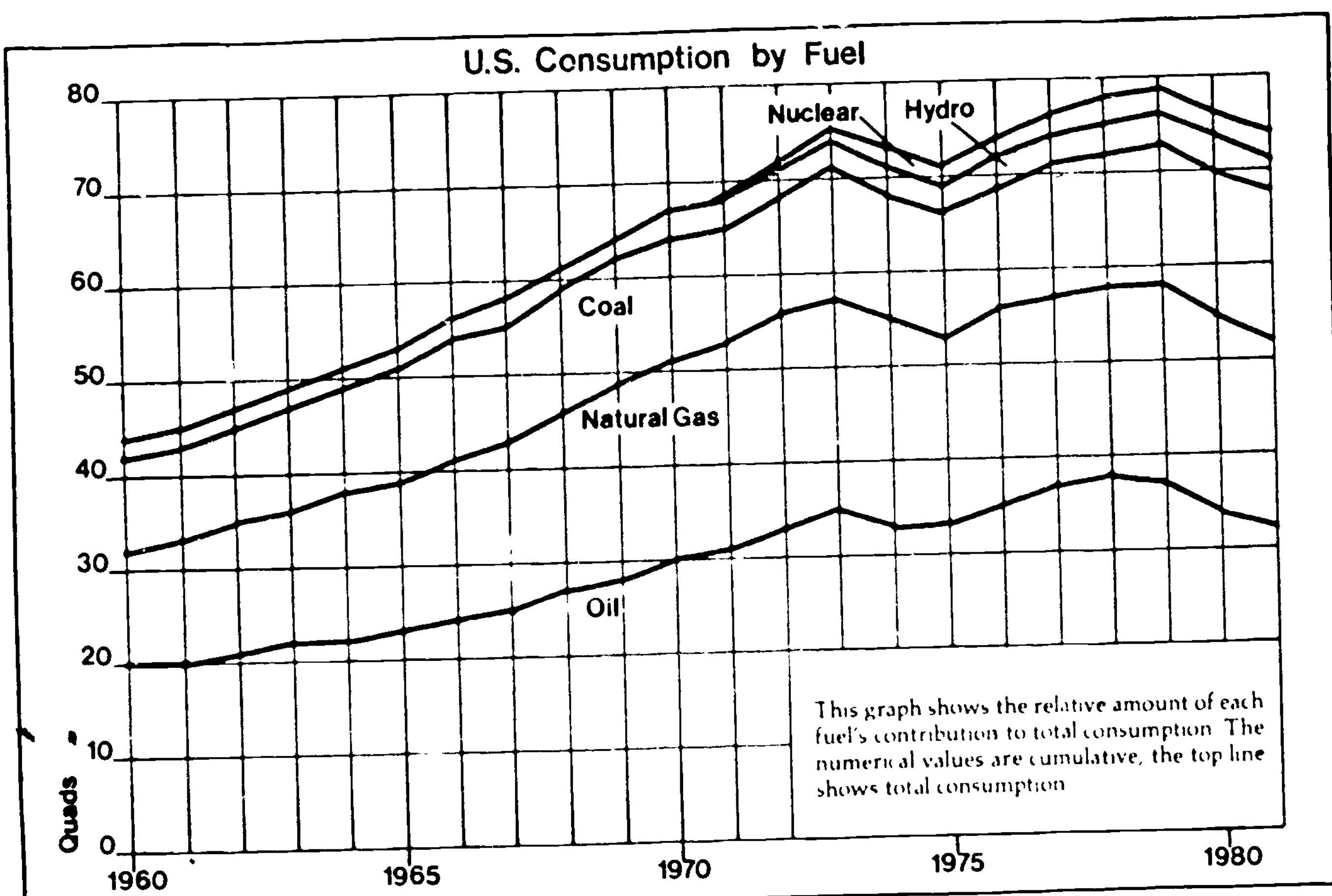
Florida does have an abundant natural energy source which is not being used to full advantage--sunshine. The only region in the nation with more solar energy than Florida is the desert southwest. Solar is a renewable, clean source of energy whose price and availability are not subject to manipulation by other nations. It is becoming increasingly obvious that the best approach to alleviating our energy problems is to combine vigorous energy conservation efforts with a serious commitment to the development of alternative resources, especially renewable resources.

An important part of the solution to the energy shortage is conservation. In order to hold the demand for energy to an annual growth rate of 2 percent or less, current gasoline consumption must be reduced by 10 percent, and 90 percent of existing homes and all new buildings will need to be insulated.

Among the several categories of conservation are some that require little or no cost outlay, while others may be expensive to implement. Some may require a change in individual lifestyle. They all will positively affect our depleting energy supply.

Student Handout 4: U.S. Energy Production and Consumption





7. SUBSTITUTION

OBJECTIVE: D. 19. Identify how substitutions can be used when a resource becomes more scarce.

MATERIALS: Student Handout: Solar Water Heating Systems

ACTIVITIES:

1. Ask students where they have heard the word substitute used in school (substitute teacher). What does that use mean? How is a substitute teacher different from a teacher?

2. Discuss the concept of substitution by asking:

   a. If hamburger meat rose to $10 a pound, what would you eat? Why?

   b. If watermelons rose to $50 each. How many would you be likely to eat during a year? Why?

   c. If gasoline rose to $18 a gallon, how much would you drive? Why?

3. Provide a definition of substitution (Latin: to put in place of). Something that is put in place of something else (using honey rather than sugar). Discuss the more economic conception: The tendency for the less costly of two or more alternatives to replace the more costly.

4. Using their concept of substitution, have students study the Student Handout.

5. Get students to examine the school or their home, looking for SUBSTITUTION opportunities to save energy dollars.

STUDENT HANDOUT

SOLAR WATER HEATING SYSTEMS

Solar domestic water (DHW) systems were once widely used in south Florida. Solar water heating was brought to Miami during the 1920 building boom. Hot water was a luxury at that time because of the high cost of gas and electricity. Solar energy provided a cheap and plentiful supply of hot water for the thousands of hotels, apartments and homes which mushroomed along Florida's coast. By the mid-1920s the solar industry in Florida was established; use of solar systems was widespread. It is estimated that approximately 80 percent of the homes built in Miami from 1937 to 1941 relied on solar water heating systems. In 1941, solar systems outsold conventional water heaters two to one. These systems were either paid for entirely in cash or were financed by FHA Title I home improvement loans. In 1938, these loans were readily available at 4 persent interest with a three year maturity.

World War II brought the industry to a halt. As nearly every component of the solar DHW system was made of copper, the government's freeze on non-military use of copper made its manufacture impossible.

After the war, many firms returned to business; however, price increases reduced consumer interest substantially. Materials had become more expensive. The cost of copper doubled in the decade between 1938 and 1948, and by the late '50's it had tripled. In 1938, a common laborer earned 25¢-40¢ an hour; a skilled roof mechanic between 75¢ and $1. By 1948 these wage scales had also doubled and solar water heating systems were priced out of the marked.

At the same time that solar prices were increasing, electric rates were decreasing. With the large number of newcomers moving to Florida after the war, power companies were able to spread investment costs over a larger base. The rate decline continued for more than 20 years, through 1970.

Large-scale production of electric hot water systems brought their price down substantially, and electric companies aggressively promoted the use of these systems. Solar was no longer the bargain it had once been, and the once flourishing industry began its decline.

With today's concern over energy shortages and price increases, the solar industry has begun an upward swing. Sales of solar DHW systems in Florida alone are estimated at $10 million for 1979. The total number of new installations in the state since 1973 is estimated at 22,000. The industry which was once a commercial success because it offered homeowners an economically superior system for heating water has been reborn.

Source: Solar Energy and the Financial Community. Florida Solar Energy Center, 1981.

8. ALTERNATIVES AND SUBSTITUTIONS IN PRODUCTION

OBJECTIVE: D. 19. Identify how substitutions can be used when a resource becomes more scarce.

MATERIALS: None

ACTIVITIES:

1. There are usually several ways of producing anything We can make shoes by hand using a few simple tools, raw materials, and lots of labor. We can use natural leather or synthetic materials or we can use complicated machinery with much less labor.

2. Labor, tools, machines, leather, synthetic materials - can be called inputs in making shoes.

3. Since we can make shoes in several different ways, how do we decide which way?

   a. If wages are low and machines are very expensive?

   b. If leather is expensive and synthetic materials cheap?

   c. If synthetic materials are expensive and leather cheap?

4. Now, let's talk about producing, not shoes, but comfort in rooms. When are we uncomfortable? When it's too hot or too cold? We can stand higher temperatures if the air is moving, or the air doesn't feel too moist.

   How can we be comfortable in hot weather (which is much of the time in Florida). One way is to have a big air conditioner and keep it running all the time. But that's expensive and gets more expensive all the time. Air conditioners use more electricity than anything else in the house and electricity keeps getting more expensive.

   Are there any other ways of being as comfortable? Yes--we can keep the house from getting so hot in the first place. Then we can let the breezes through the house and feel comfortable most of the year. Why do houses get hot? Because the sun heats them up. The roof gets very hot, and that heat radiates down into the house. Sunlight comes through the windows and heats up the house. The sun heats up the walls and that heat radiates into the house and into our bodies so that we feel hot.

   Maybe it's cheaper to keep the heat away from us and then not run the air conditioner so much. That's just another way to be comfortable, just like there is another way to make shoes. In fact, as electricity gets more expensive, we might want to change the ways we make ourselves comfortable in hot weather.

5. What are some ways to keep our houses from getting so hot, or <u>feeling</u> so hot to us?

   a. Plant trees to shade our walls and our roof.

   b. Shade our windows, especially on the east and west--that's when the sun comes in during mornings and afternoons when it's lower in the sky.

   c. Insulation in the roof can help keep the rooms cool even when the sun is making the roof very hot.

   d. We can put shiny materials like aluminum foil just under the roof. That works like a mirror, and reflects heat rays back toward the sky. That way they can't and heat up the house.

<u>EXERCISES</u>:

1. Is there any insulation over the ceilings in your house?

2. In the late afternoon, stand near a west wall that receives sunshine. Do you feel warmer there? Does the wall feel warmer? Walls absorb heat and can store it for hours. If you are trying to keep cool, the wall should be shaded, insulated or isolated from the living spaces.

9. FACTORS OF PRODUCTION

OBJECTIVES: D. 21. Identify the factors in production like natural resources, labor, capital, and management.

D. 22. Identify how energy factors affect the cost and availability of goods and services.

MATERIALS: Student Handout: A Solar Water Heating System

ACTIVITIES:

1. Ask students what factors "go into making a product for consumers." Identify these as natural resources, labor (human resources), capital (capital resources), and management (technological acumen, entrepreneurship). Explain this in terms of the following:

   Before goods and services can be consumed, they must be produced. For this to occur, productive resources (also called factors of production) are necessary. Productive resources constitute the input to production, while the goods and services produced constitute the output. There are several kinds of productive resources.

   Natural resources are the gifts of nature used to produce goods and services. They include land, water, oil and mineral deposits, the fertility of the soil, climates suitable for growing crops, timber, and so on. Some of these resources are used up in the process of production, others renew themselves, while still others can be renewed through the conscious efforts of people.

   Human resources are people with their physical and mental capacities. The number of people available for work and the hours they work constitute one dimension of labor input. Another is the quality of the labor skills provided and the motivation of those who provide them. The quality of labor force reflects past efforts to improve skills and knowledge by means of education and training.

   Capital goods are those things created by man's past efforts that are available to produce goods and services in the future. They include machines, tools, and factories. The kinds of capital goods used and how they are used reflect the state of technology which, in turn, is a reflection of scientific knowledge and the resources devoted to acquiring this knowledge.

2. Study the Student Handout. Identify the factors of production necessary to produce and install the solar water heating system depicted in the illustration.

3. Work with students to reason through these questions:

   a. If labor becomes more expensive, costs for products and services will _________. (rise)

   b. If labor costs go up 10%, will the costs of goods and services go up 10%? (no, labor is but one factor of production)

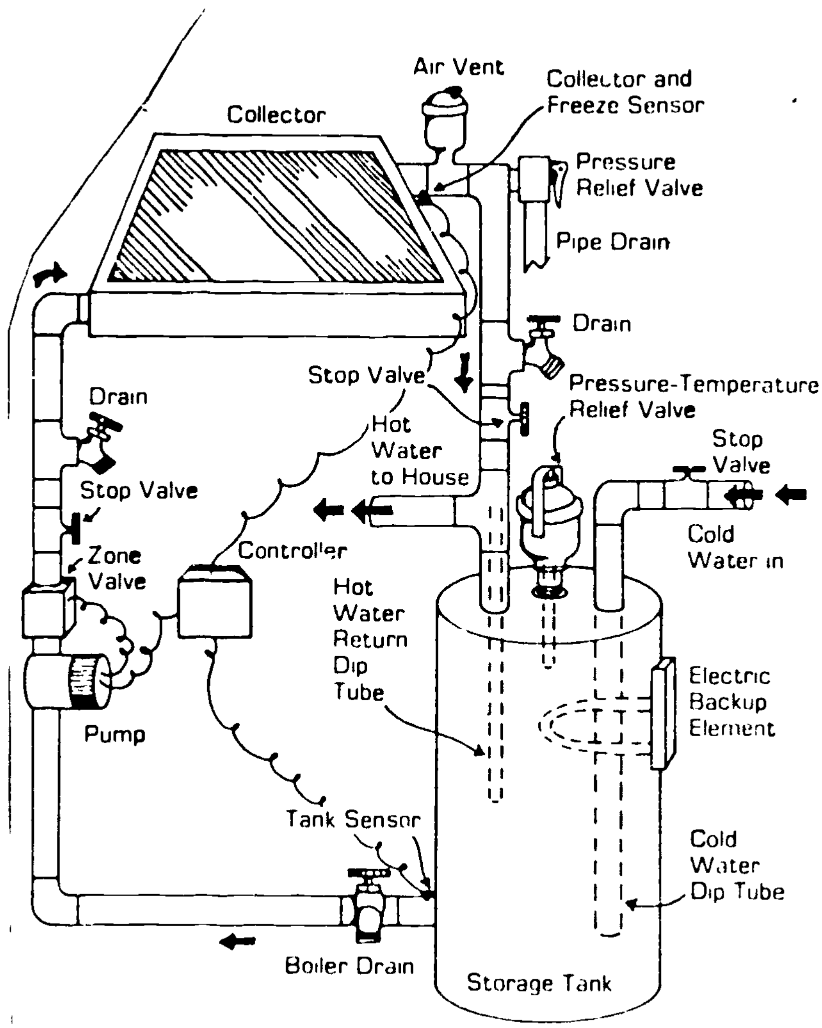
   c. Will the costs of all goods and services go up by the same percentage? (no, some are labor intensive and will go up more than those which are capital intensive)

   d. Energy is a primary need in producing everything. Energy is used as a natural resource, such as oil in plastics, coal in the manufacture of synthetic fibres, etc. Energy is also used in operating plants, running the transportation system, etc. If energy costs rise, will costs of all goods and services go up? (yes) By the same percentage? (no)

   e. Name some products or industries in Florida which are energy intensive. (transportation, electric generation, agriculture).

FACTORS OF PRODUCTION

Student Handout: A Solar Water Heating System



Typical Direct Pumped System

10. ECONOMICS OF SMALL WIND MACHINES

OBJECTIVES: E. 24. Define capital goods as tools, equipment, machinery and buildings that are used in the production of other goods and services.

E. 25. Define profit as the reward for taking risk in business.

E. 26. Define net profit as remainder after all costs, expenses, and taxes are satisfied.

MATERIALS: None

ACTIVITIES:

1. Our first step is to measure the available resource--wind energy. Study the information in Table 1.

Table 1. Average Wind Speeds at Cape Kennedy AFS (1950-1970)

Wind Direction	Avg.	N	E	S	W
Actual avg. speed at 30ft (mph)	9.2	10.7	9.1	8.5	8.5
Estimated avg. speed at 60ft (mph)	10.0	11.7	9.9	9.3	9.3
Estimated avg. speed at 80ft (mph)	10.5	12.2	10.3	9.7	9.7
Estimated avg. speed at 100ft (mph)	10.8	12.5	10.7	10.0	10.0

The cost of a complete wind generating system is:

Enertech 1800: Complete windplant and control system	$ 4,250
Control anemometer wire per 100 ft	26
Options: Additional corrosion resistance treatment for corrosive environments	165
One Rohn 80 feet guyed Tower	2,055
Total	$6,495

Table 2. The Enertech 1800 Output Characteristics

Average Windspeed (m.p.h.)	kWh/mo
8	120
10	240
12	360
14	480

2. Now we are ready to look at the economics of our wind energy system to generate electricity. Complete the following table:

Windspeed/Height	Average Speed*	kWh**	Value at 9¢ per kWh
30 ft.	9.2	_____	_____
60 ft.	10.0	_____	_____
80 ft.	10.5	_____	_____
100 ft.	10.8	_____	_____

*From Table 1
**Calculate from Table 2

3. Assume that it is 1985 and windy and that our 80 foot high wind generator receives an average of 12 mph wind speed. How much energy did it produce that year? _____ kWh/year

   a. Some persons have projected electric rates to be 12¢ per kWh by 1985. What would be the value of your wind generated electricity?

   b. Calculate the simple payback using the value developed in "A" above: _____ years

   c. Suppose you invested the cost of the wind generator in tax-free bonds paying 10% interest. Compare the return on this investment with the return on your investment in the wind generator. Write a paragraph describing your assumptions and develop a conclusion about wind electric generating systems for Florida consumers.

   d. Are wind generators good capital investments in Florida? Tell how a wind generator is a capital good. In your earlier calculations, what was the return ("profit") on owning and operating a wind generator?

   e. Write to the Clearwater Sun Newspaper, Clearwater, Florida, and ask for information on the economics of its wind generating system.

11. TECHNOLOGICAL PROGRESS

OBJECTIVE: F. 33. Identify how technological progress might result in lower prices, increased productivity, and a better quality product.

MATERIALS: None

ACTIVITIES:

The Florida Solar Energy Center (FSEC) has calculated and published energy ratings on more than 400 solar collectors. FSEC has been testing and certifying solar collectors since 1977 when a Florida state statute (FS377.705) established the program. In 1980, the certification program became mandatory for all solar collectors manufactured or sold in the state. Minimum standards for collectors were developed and tests with which collectors would be judged were selected or developed.

The average rating of solar collectors tested in 1977 was 6900 kJ/m^2 (608 Btu/ft^2) per day at the intermediate temperature. By 1981, the average rating had climbed to 9200 kJ/m^2 (811 Btu/ft^2) per day, an increase of 33 percent. This is an improvement significant to the industry and significant to the consumer.

The increase in performance is accounted for by improved designs, construction and materials.

Table 1. Yearly Average Performance of Solar Collectors (Btu/sq ft)

Year	Number Certified	Average Rating	Maximum	Minimum
1977	7	663	723	568
1978	26	680	850	559
1979	26	699	875	475
1980	95	732	926	414
1981	149	815	994	429
1982	31	826	933	625
ALL	334	770		

ACTIVITIES:

1. Graph the data from Table 1. Use the average rating in Btu/sq ft to make your graph.

2. Calculate the efficiency of the average flat plat collector by year. The total amount of energy available is a constant 1600 Btu/sq ft.

$$\text{Efficiency} = \frac{\text{Btu's collected}}{\text{Btu's available}} \times 100\%$$

3. Economic efficiency involves getting the most value per dollar. To compare collectors, the economic comparison would be the cost per delivered Btu. Table 2 shows the average cost per square foot of collector for the last few years and some projected costs.

Table 2. Average cost for flat plate collectors (single glazing, selective surface)

Year	Cost Per Square Foot	Cost Per BTU
1977	$25	
1978,	$27	
1979	$30	
1980	$30	
1981	$32	
1982	$32	
1983	$35	
1984	$35	
1985	$35	

Complete Table 2 by calculating the economic efficiency in terms of cost per Btu. You will need to project the date in Table 1 to 1985. Be able to justify the figures used in your projection.

4. Prepare an oral report identifying the factors that have increased the thermal performance of the collectors from 1977 to 1985.

12. DEMAND FOR SOLAR

OBJECTIVES: G. 34. Define demand as the amount of goods and services that buyers are willing to buy.

G. 39. Define demand as the amount of goods and services that buyers are willing to buy at each specific price in a given market at a given time.

MATERIALS: Student Handout: Photovoltaic Cells by A. Litka

ACTIVITIES:

1. Define the concept of demand for students.
   Demand reflects the amounts that consumers will be willing and able to buy at various possible prices during the same time period. As a general rule, the lower the price, the more will be demanded and vice-versa.

2. Begin to discuss the relationship between demand, supply and price. Use the following examples and let students suggest more:
   Assume that the class sells soft drinks every Friday after school. How would the market demand for soft drinks change if:

   a. Parents ask their children not to buy soft drinks for health reasons. (Decrease.)

   b. Small pieces of gravel are found in the drinks. (Decrease.)

   c. Several students get an increase in their allowance. (Increase.)

   d. Price doubles. (Decrease.)

   How would your demand for peanuts at the movie theater change if:

   a. Price of popcorn drops. (Decrease.)

   b. The theater offers a free drink with each bag of peanuts. (Increase.)

   c. You give up your paper route, which reduces your income? (Decrease.)

3. Have the students read the Handout: Photovoltaic Cells. Ask them to look for comments on the demand for photovoltaic cells now. Ask them about price and supply. What are the relationships?

4. Ask them the following:

   a. What might well happen to photovoltaic cell prices if the demand shot up over the next six years?

   b. Why isn't the supply of photovoltaic cells greater today, than it is?

c. Why is it that high prices lower demand? Lower prices increase demand in such products?

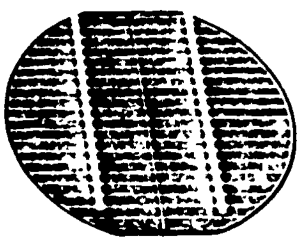
5. Discuss the Solar Trap. With limited demand at high prices, the industry cannot get the demand (volume of sales) which will permit the lowering of prices. Price reductions are slow in coming and are based upon technological breakthroughs, not supply increases.

PHOTOVOLTAIC CELLS:
Common Power Source for Tommorow?

Arthur H Litka Associate Engineer

The word photovoltaic combines the scientific terms "photo" meaning light, and "voltaic", meaning voltage Together the terms mean voltage generated by light energy Specially treated silicon, or another substance, is constructed in such a way that when light strikes it electricity is produced The cells have no moving parts, and they are durable They are commonly called solar cells

While silicon is not the only material used in making solar cells, it has undergone the most development since its first use, in 1954 Many space satellites have used silicon solar cells to provide their energy needs for the last two decades If they are so good, why aren't we using them to power our homes today? The answer is cost Since the major demand for them has been for spacecraft, large-scale mass production techniques have not been developed to meet a large commercial market demand



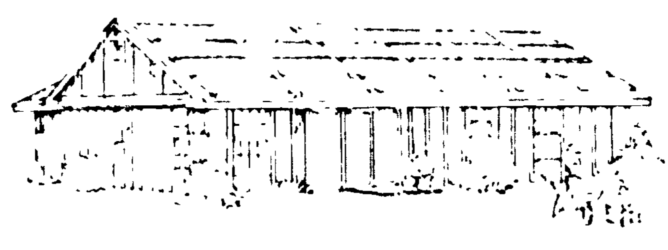
Today as costs of conventional energy sources such as oil and coal continue to rise, solar cells appear more and more attractive for a variety of applications, including electricity for most of a modern home's needs The U S Department of Energy (DOE) is seeking to create a new market for solar cells by funding both basic cell research and photovoltaic experimental projects involving concentrating (sun-tracking) and non-concentrating collector arrays DOE expects that by 1986 the photovoltaic market will have developed to a point at which cell prices will be competitive with conventional forms of electricity generation A competitive price goal is considered to be between 50¢ and $1 per peak watt Current prices are approximately $7 to $12 per peak watt

Assume then that solar cells could be produced at a cost making them economically attractive for home use The next step is to connect enough of them to produce sufficient electrical power When sunlight strikes the cell's surface direct current (DC) electricity is produced By wiring a large number of cells together, a photovoltaic array is created which can generate as much electricity as desired However, since most home appliances use alternating current (AC), the direct current produced by the cells must be converted to AC An electronic device known as an inverter performs that function When sunlight hits the photovoltaic array, the direct current electricity generated is converted to 240/120-volt, 60-cycle alternating current by the inverter This is the standard operating voltage for most home appliances

In order to supply adequate electricity for household needs photovoltaic arrays ranging from 500 to 1,000 square feet in size would be required One possible approach is to cover a south-facing roof with the cells The array could be made to resemble roofing shingles, thus, in outward appearance the house would not look much different than one conventionally powered If sufficient roof area were not available, the array could be mounted on the ground Cells normally are arranged in the form of flat rectangular panels facing south and tipped at an angle equal to the site location latitude

What happens when the sunlight is weak, or there is no sunlight at all? Clouds cause variations in the amount of solar intensity, or insolation, and since the photovoltaic array's output depends on how much light strikes it, obviously the electricity supply will not be steady And at night or during rainy weather it will, of course, produce no power at all

There are solutions to this problem Since the photovoltaic array output is direct current electricity, it can be used to charge storage batteries By designing the photovoltaic system properly, batteries could be kept charged sufficiently to supply power to the home at any time To generate the required AC electricity, the batteries would be connected to an inverter Another approach is to use a utility synchronized inverter without batteries The AC outlet would be variable but the utility service would instantaneously supply any extra needed power Obviously, at night or during overcast periods, the utility would supply all of the power However, on sunny days it is possible that the solar system would supply **more** power than the house requires Under this condition the utility meter will run **backwards** and yield an energy credit for the homeowner! Because of the high cost of storage batteries, this concept might be the economical approach In fact, the Center's experimental photovoltaic house operates in just this manner today



This has been only an exploration into what might happen a few years from now--dispersed photovoltaic systems on individual homes (or larger residential and commercial structures, for that matter) On the other hand it is possible that we may also see central photovoltaic utility plants serving whole communities More information on photovoltaic systems may be found in

--**Non-Technical Summary of Distributed Solar Power Collector Concepts,** 45¢, Document No SE-102, Stock No 060-000-00008-5, Government Printing Office, Washington, D C 20402

--**Solar Electricity: From Dream to Scheme,** by John H Douglas, Science News, May 15, 1976, pp 316-318

--**New Ways to Make Solar Cells, Trim Costs of Future Power for Your Home,** by Edward Edelson, Popular Science, May 1976, p 74

--**Photovoltaics, an Overview--Solar Cells: State of the Art,** by David Norris, Solar Age, April 1976, pp 8-14

--**Electricity From the Sun!--Solar Photovoltaic Energy,** by John M Fowler, Order No EDM-1043-4, Technical Information Center, P O Box 62 Oak Ridge, TN 37830

--**Solar Electricity From Photovoltaic Conversion,** Order No DOE/OPA-0011, Technical Information Center, P O Box 62, Oak Ridge, TN 37830

13. MARKETPLACE

OBJECTIVES: G. 35. Define marketplace as a setting where goods and services are bought, sold, or traded.

I. 48. Define distribution as the process for getting products from producers to consumers.

MATERIALS: Two solar advertisements.

ACTIVITIES:

1. What is a market? What is a marketplace? (Draw pictures of a market...and a marketplace). The market is the mechanism that answers those questions about what to produce, how much, and for whom. It establishes and it reconciles the changing relationships between buyers and sellers, with each trying to do what he or she thinks best. Buyers compete with each other to obtain goods and services at the most favorable price. Sellers try to dispose of their goods or services on the most favorable terms.

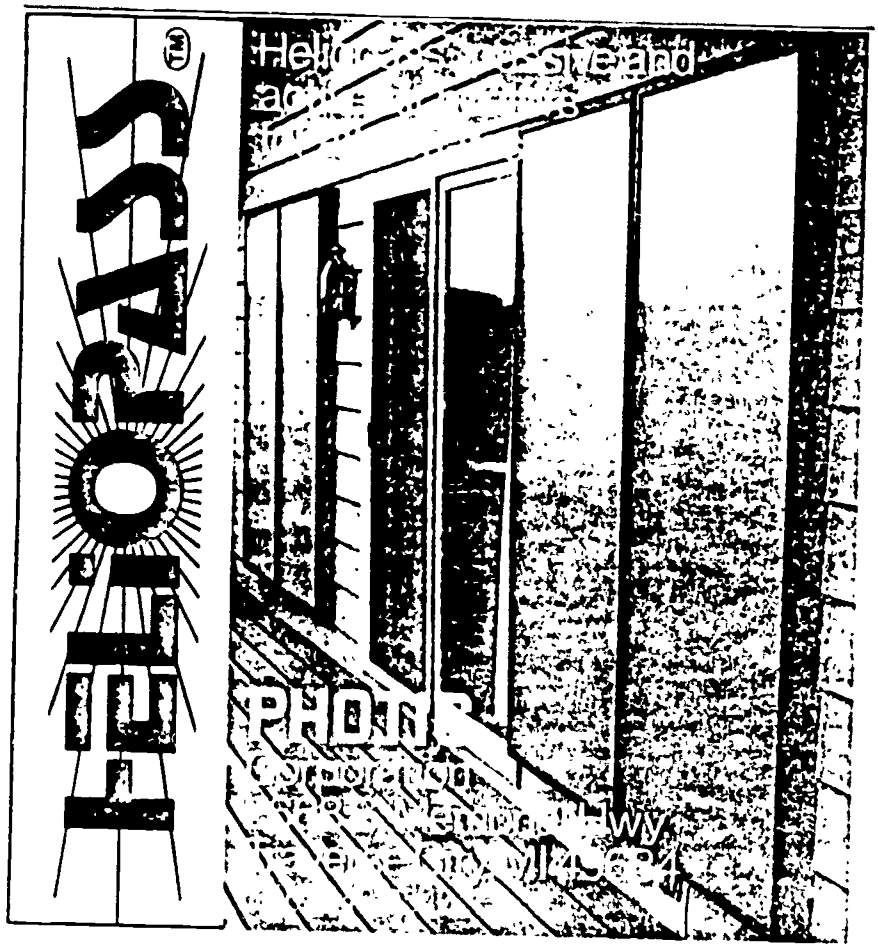
   Nobody designed the market system; it evolved. The tangle of relationships is enormously complex. And yet the market system is able to mesh the knowledge and actions of millions of individuals and business firms. Take, for example, the economic life of a large city. Overnight, foods and goods necessary to the city's survival are delivered in the right quantities and right kinds to thousands of restaurants, supermarkets, and stores. It is an enormously interdependent operation, requiring a bewildering number of individual decisions. And yet most citizens take for granted that their needs will be supplied.

2. What does a "market" look like for solar equipment for the homeowner? Where is the "marketplace" to be found?

3. Read two solar equipment advertisements and tell what they reveal about the market and the marketplace for such items.

4. What is the function of the solar equipment marketplace? (Distribution places for solar goods and services).

5. Study your school to see marketplaces linking producers and consumers, e.g., school store, cafeteria, athletic office.



14. SUPPLY AND DEMAND

OBJECTIVES: G. 37. Name some factors which may influence the supply of a good or service.

G. 38. Name some factors which may influence the demand for a good or service.

MATERIALS: None

ACTIVITIES:

1. Review with students the following information about the relationship between supply and demand: Buyer demand is governed, in part, by pricing, and, in part, by preference. But demand also refers to the quantities of goods and services people are willing and able to buy at a certain time. So, too, with the word supply. Supply refers not only to particular goods and services that may be offered at a certain price, but also the quantity of goods and services offered in a range of prices.

   When demand is strong, buyers compete for the same goods, bidding prices upward, which, in turn, increases the producer's potential for profit. This added incentive for profit encourages businessmen to increase production. Sometimes new producers enter the market, further increasing the supply.

   As more goods are offered consumers, competition among the sellers tends to drive prices downward. Thus, in a market economy, there is a strong counterbalance between supply and demand, and prices seek their own level.

2. Have students consider this situation. The world is running out of nonrenewable energy resources. As we use up the resources that are easy to find and extract, it gets more difficult and costly to get more energy. It will be necessary to replace nonrenewable energy resources with renewable ones. One promising renewable energy resource is solar photovoltaic (PV) cells--direct production of electricity. The problem, however, is that PVs are still more expensive than conventional electrical sources. The dilemna is that if more PVs were produced, the price would likely come down. If the price came down, more people would buy them (substituting PVs for conventional electrical sources). To bring the cost down will require enormous capital investment in equipment (manufacturing facilities). In a free market system, what incentive is there for a company to invest millions of dollars to bring down the cost of a product when it competes with a proven, low-cost technology? In other words, this would be a high risk, potentially long term payoff investment.

   If you had $100 million to invest, would you invest in PVs, coal mines, uranium, oil, or McDonald's restaurants? Why?

3. What might happen if each of the following occurred?

   a. Research makes PVs much cheaper to make and install?

   b. Electricity from power plants gets far more expensive?

   c. PVs make electricity only when the sun shines; they do not work at night. But someone invents and markets low-cost batteries to store electricity?

   d. People agree to consume most of their electricity during daylight hours?

15. PRICE AND COST

OBJECTIVE: H. 43. Define price as the money value set for goods or services.

MATERIALS: Student Handout: Cost and Price

ACTIVITIES:

1. Ask students what they think the term price means, and how the term price is the same as, or different from, the term cost. To economists, the cost is what you give up to buy a good or service (opportunity cost), price is the rate at which money is exchanged for goods and services. But prices are more than expressions of value. They also reflect shifting conditions of supply and demand. And so the price mechanism serves as a guide for the quantity, the quality, and kinds of goods to be produced.

2. Ask students how they would figure out the "fair price" for a solar water heater in Florida. Read the Student Handout. What are the ingredients in the pricing for such collectors.

3. Ask students if they would be willing to "pay" the opportunity costs of installing a solar water heater. What would they have to give up...?

4. Develop an evaluation plan where students have to distinguish between PRICE and COST...perhaps they might use a questionnaire with their parents distinguishing between the two concepts as applied to conservation and solar energy use at home.

STUDENT HANDOUT

COST AND PRICE

Installed Costs

Solar system costs, including all equipment and labor, require a significant investment. Labor costs are difficult to estimate as the number of man-hours required depends upon the installer's experience, type of installation, site location, and building type. Equipment costs may be obtained from manufacturer and dealer price lists. Table 1 lists retail price ranges for various components of a solar water system. While more or less expensive components can be found, these representative costs are provided as a guideline.

Table 1. Component Cost Range for Typical Florida Direct Solar DHW Systems.

	Low	High	Average
Flat-Plate Collector (ft^2)	$ 12	$18	$15
Storage Tank (80-82 gal)	225	575	290
Pump	55	122	86
Sensors & Controls	60	130	100
Pipes, Valves, Insulation	100	216	140

Currently, the price of a solar domestic hot water (DHW) system installed in Florida ranges between $1,200 and $3,000. As a statewide reference for comparison, a direct solar DHW system sized to supply a recommended 70 percent of the hot water for a family of four will retail on the average for about $2,200. Systems that use heat exchangers (i.e., indirect systems, which are more appropriate in regions where freezing conditions regularly occur) cost $200 to $600 more, depending on the type of heat exchanger used.

Do-it-yourself systems may cost as little as $500 and can be as efficient as those systems installed by professionals. System kits, which provide a packaged set of compatible components, can also be purchased.

The cost to install a DHW system in an existing building is usually about 15 percent more than in new construction because retrofit installations may require modifications to the building.

16. ADVERTISE THE SUN?

Objective: I.45: Define advertising as a means to inform people about a firm's products or services, or to persuade people to purchase a firm's goods or services rather than those produced by a competitor.

Materials: Two solar advertisements

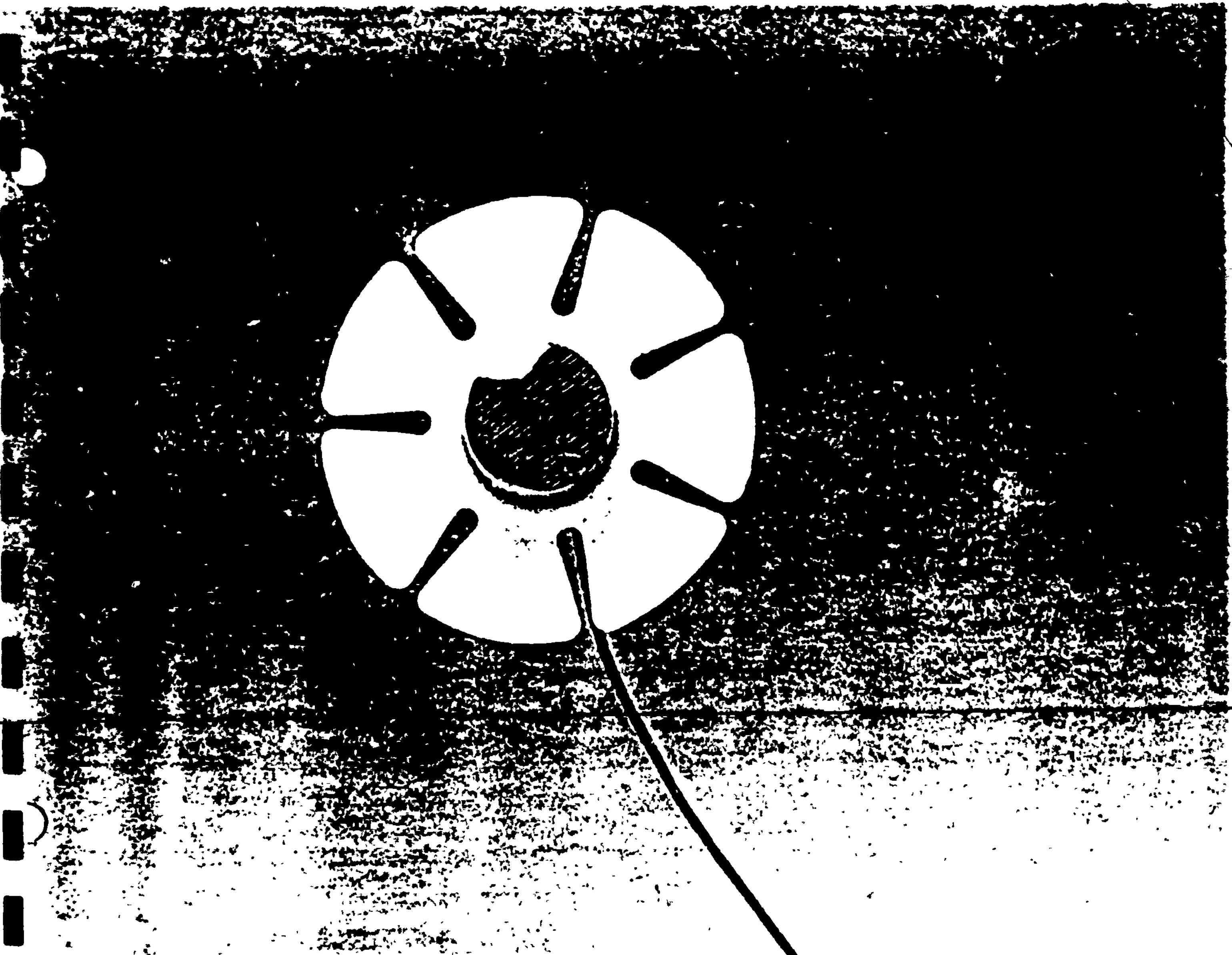
Activities:

1. Look the word advertisement up in your dictionary. What does it mean? What does the term advertise mean? What does it mean to advertise? Where does the root of the word come from . . . what language?

2. What is the purpose of advertising in America . . . in our free enterprise, market economy? List the purposes as the students see them on the chalkboard.

3. Examine two solar equipment advertisements. What is their purpose(s)? . . . implied and expressed. What advertising techniques are used?

4. If the claims in the advertisements were false or misleading, how would the smart consumer know? What would she look for? How could she get good information?



Let the Sun Shine

And bring your Solar Sunflower to full bloom. It's an eye-catching conversation piece that will decorate your windowsill or garden. Using the principal of photovoltaics, a three inch silicon solar cell changes sunlight directly into electricity and powers a small electric motor which spins the nine inch yellow plastic petals. It's quite a sight; no sound, no batteries or wiring, just Mother Nature demonstrating her solar power.

The two foot long green stem can be bent into any shape and placed on a desk, table, window box, lawn furniture, or snuggly buried in your lawn. You can even line the patio with solar sunflowers for a spinning reception. No doubt about it you'll be the talk of the party, with a little help from Mother Nature.

SOLAREX

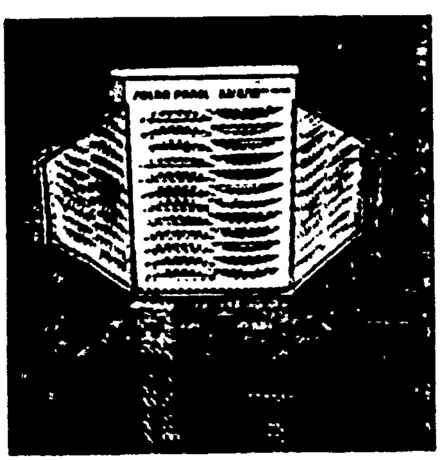
Solarex Corporation
Consumer Product Dept.
1335 Piccard Drive
Rockville, Maryland 20850 USA
(301) 948-0202
TELEX 248359 SOLX
TWX 7108289709
CABLE SOLAREX

Consumer Products
Item Number 5500
Solar Sunflower

Solarex Corporation

Mother Nature Sends Her Best

And you're ready to receive it with the Solarex multivolt mini panel It's an ideal compact power source that converts nature's sunlight directly into electricity The multivolt mini panel is composed of twenty-four crescent shaped silicon solar cells connected in series The cells are mounted in an attractive and sturdy 4½ X 5¾ inch black plastic case The plastic faceplate is comprised of hundreds of bubble magnifiers which maximize cell performance as they enhance the light striking the solar cells Two 4 X 5 reflector panels fit on either side of the case and increase cell efficiency even more



Weighing a mere five ounces, it comes complete with a mini plug and seventeen inches of cord Achieve the desired voltage by plugging into either the 3, 6, or 9 volt jacks located at the top of the panel.

A delight for the beach enthusiast or backyard hobbiest. Under full sun the multipanel will deliver 50 milliamps of power at all voltages, making it an ideal battery substitute for radios, small motors, lamps and other small appliances So there you have it, a maintenance free, silent, long lasting power source What more can you ask of "Mother Nature"

SOLAREX

Solarex Corporation
Consumer Product Dept.
1335 Piccard Drive
Rockville Maryland 20850 USA
(301) 948 0202

TELEX 248359 SOLX
TWX 7108289709
CABLE SOLAREX

Consumer Products
Item Number 552040
Multivolt Mini Panel

17. ADVERTISING AND PROPAGANDA

OBJECTIVE: I. 45. Define advertising as a means to inform people about a firm's products or services, or to persuade people to purchase a firm's goods or services rather than those produced by a competitor.

MATERIALS: Ads concerning solar products or services

ACTIVITIES:

1. Define ad and advertisement.
2. Have students collect ads from energy publications or news magazines.
3. Review the eight points (ploys) that advertising agencies have discovered that sell products.
4. Evaluate ads to find which of these points each contains.
5. Compare ads that are showing the same kinds of products (solar film, solar pool heaters, solar water heaters, etc.).
6. Have students determine:
    a. Is this product something that will benefit me?
    b. My family? My community? My state? My country? My world?
    c. What are the direct benefits?
    d. What are the indirect benefits?
    e. Are there cost benefits?
    f. How can we determine the cost benefits?
7. Invite a local representative of a particular product to speak to the class.
8. Have students design an ad to sell a solar energy product.
9. Compare the propaganda techniques used by competing energy companies (coal, gas, solar).

PROPAGANDA TECHNIQUES

1. Appeal to Pity - Seeks to produce sympathy and pity to influence your opinion.
Example - "America's poor, already trapped by rapidly rising prices for food and housing, are expected to be hardest hit by a 50¢ a gallon tax on gasoline."

2. Appeal to Prestige - Urging the acceptance of an idea as a means of raising your status.

3. Appeal to Ridicule - Attempting to make fun of someone or something in order to influence your opinion.
Example - "Conservation is ignored in the President's energy budget. Obviously, conservation is not good business for the oil companies that donated $280,000 to redecorate Ronald Reagan's White Hourse living quarters."

4. Bargain Appeal - Attempting to get you to buy an item by appealing to your desire to save money.
Example - "This is your last chance to buy a brand new Opex automobile at 1981 prices."

5. Appeal to Flattery - Attempting to persuade by flattering a person in an area in which he would like to excel.
Example - "Physically fit students tend to use bikes for transportation in order to conserve our valuable natural resource."

6. Slogan Appeal - Promotes a favorable response or positive action through short catchy phrases.
Example - "Save It, Florida." "Extinct is Forever."

7. Technical Jargon Appeal - Impresses with the use of technical language or unfamiliar words.
Example - "Durawear tires contain durium, the bonding material that makes these tires wear for years."

8. Danger/Survival Appeal - Refusing to act in a certain manner will result in harmful consequences.
Example - "The Union of Concerned Scientists predicts a one-in-five chance of a catastrophe for one of our current reactors during their 30 to 40 year lifespan."

18. CONSUMER MATH

OBJECTIVE: I. 46 Recognize misleading and non-misleading advertising.

MATERIALS:

ACTIVITIES:

A common method of advertising and selling is to make statistical claims for products. Statistics are applicable to group averages, but not necessarily to specific individuals. For example, statistics show that 30 percent of electricity sold to homeowners is used for heating water. This figure is based upon all residential customers over an entire year. Melvin may use 40 percent of his electric consumption in July to heat water, but only use 16 percent in February. Sally may only use an average of 10 percent of her electric consumption on water heating.

1. Suppose that a retired couple receives an electric bill of $200 on August 15th. Does this mean that 30 percent of the bill is for hot water? (no) Why? or Why not? (30 percent of $200 is $60)

2. If electricity costs 8¢ per kWh, how many kWh will $60 buy? (750 kWh)

3. If 1 kWh will heat 6 gallons of water from 71°F to 140°F, how many gallons of hot water will $60 make? (4,500 gal)

4. How many gallons per day is this, if a month has 30 days? (150 gallons)

5. How many gallons a day is this, per person? (75 gallons per person)

6. If a person can be expected to use about 20 gallons of hot water per day, how many gallons would this household use per day? (40 gallons)

7. Compare your answers to #5 to your answer to #4.

8. How many gallons would this household use in a month (30 days)? (1,200 gallons)

9. How many kWh are needed to heat this water (200 kwh)?

10. What would the costs for this heating be at 8¢ per kWh? ($16)

11. What would be the most money per month that this family could save with a solar water heating system? ($16)

12. How much could a family of four save if the sun were to heat ALL of their water? ($32)

13. If a solar system provides 80% of the hot water needs of a family of four, how much would it save in a month? ($25.60)

14. How many kWh are needed to provide hot water for a family of four for a day? (13.3 kwh)

15. If a kWh provides 3413 Btu, how many Btu of hot water are needed per day? (45,393 Btu)

16. A solar collector is rated at 39,000 Btu per day. What fraction of the family's needs will it provide? (86%)

17. The sun will provide about 0.5 kWh per sq. ft. per day for heating water. How many square feet are needed to provide 13.3 kWh per day? (26.6 sq. ft.)

18. The best solar collectors are about 50% efficient. How many sq. ft. of these collectors are needed to produce 13.3 kWh per day? (53.2 sq. ft.)

19. How many kWh per day will a 40 sq. ft. collector produce? (10 kWh/day)

20. How many Btu per day is this? (34,130 Btu/day)

21. What is the efficiency of the 39,000 Btu/day collector if its size is 40 sq. ft? (57%)

22. Will a 4 ft x 8 ft solar collector make $15 per month worth of hot water? How about $40 per month worth of hot water?

23. Prepare a set of guidelines people can use when they are evaluating the claims for solar water heaters.

19. COMPARISON SHOPPING

OBJECTIVE: K. 51. Identify some benefits of comparison shopping.

MATERIALS: More than ever homeowners are considering the costs associated with water heating. The following analysis provides a comparison for some systems:

(1) The standard resistance electric hot water heater; there is no savings.

(2) A heat recovery unit attached to an air conditioner heats water while the air conditioner is cooling.

(3) A dedicated heat pump is a small compressor much like those used in refrigerators. This system works in reverse, heating water instead of cooling the refrigerator.

(4) A solar system designed to use solar energy to heat water.

Table 1. Average System Cost and Current Annual Savings Per Year

Type of Water Heater	Average Installed Cost	Tax Credit	Net Installed Cost	Current Annual Savings/Yr	% Annual Savings/ Years	Simple Payback Years
Electrical Resistance	$ 200	0	$ 200	$ 0	0	$ 0
Heat Recovery Unit (New)	580	0	580	100	.38	5.80
Heat Recovery Unit (Retro)	700	0	700	117	.45	5.98
Dedicated Heat Pump	900	0	900	130	.50	6.92
Solar	2200	40%	1320	182	70	7.25

Table 1 was prepared using the following assumptions:

1. There is an 80 gallon per day hot water demand.

2. Electricity costs 5¢ per kilowatt hour (kWh).

3. 5200 kWh's are used to heat water ($260 per year).

ACTIVITIES:

1. Study the information contained in Table 1 and determine which water heating system is "the best buy." List the factors which led to this conclusion.

2. Since Table 1 was constructed, electricity has increased to 8¢ per kWh. Recalculate Table 1 using this new cost figure. The current annual savings and the simple payback will change. Be sure to check your numbers.

3. Re-evaluate your answer to 1. Have you changed your mind? List the factors that influenced your decision.

20. GOING SOLAR

OBJECTIVES: K. 51. Identify some benefits of comparison shopping.

K. 52. Identify how consumer choice involves giving up other alternatives.

MATERIALS: Solar Water Heating: A Question and Answer Primer

ACTIVITIES:

1. Ask students the following questions:

    a. What is solar energy?

    b. How much does a typical solar water heater cost?

    c. What government help is available to install such a heater?

    d. How much do families usually save in electric bills?

2. Try these situations:

    a. Assume that you are 20 years old, earning $10,000 per year and are buying a home. Should you go solar?

    b. Assume that you are 30 years old, earning $20,000. You are buying your home with the help of a bank, and have a spouse and two children. Should you go solar?

    c. Assume that you are 50 years old, earning $30,000 and own your home. Should you and your spouse go solar?

As students are discussing their responses, intervene with these facts:

    a. The company you work for is in trouble and you might be laid off or have your wages cut back.

    b. Interest rates just hit 17% and look like they might go higher.

    c. You see the boat you've always wanted, at just the right price.

3. Ask the students which of the following arguments might deter them from buying solar water heaters:

    a. John Denver and Alice Cooper have solar heaters.

    b. Interest rates are 18% and holding.

    c. Superior Oil Company just announced a discovery of petroleum equal to all the oil consumed in the world to date. Oil will be cheap again.

d. The government wants you to go solar.

e. Solar will save you $300 per year for 20 years or so.

f. A good solar water system costs $2,200 installed.

4. With your students, discuss whether solar water heaters are "wants" or "needs" in Florida. Design an advertisement for solar perceived as a basic "need" for Floridians, or design an ad for such a system seen as a "want," or desirable consumer good.

Solar Water Heating
A Question & Answer Primer

The mounting interest in use of solar energy has generated great numbers of inquiries to the Florida Solar Energy Center (FSEC) about the technology in general and solar water heating in particular. Presented here are answers to those questions most frequently asked about solar domestic water heating in Florida. Note that many answers are approximate, and much more explanation is required for readers who are seriously interested. For additional technical information on sizing and installation, write to the FSEC Public Information Office, Cape Canaveral, FL 32920.

Question One
What is a solar water heater?

A solar water heater uses the sun's energy to heat water, thus reducing one's monthly utility bill. Many thousands of solar water heaters were in use in the Miami area during the 1930s, 40s and 50s. Their use declined in the late 1950s, but they are becoming popular again as electricity and fuel prices rise. Solar water heaters conserve conventional fuel and are non-polluting. If installed properly, they are usually economical over the life of the system as opposed to heating water with electricity or propane.

In the mild Florida climate the most widely used type of solar water heater pumps potable water from the water storage tank through one or more collectors and back to the tank. The circulating pump is regulated by an electronic controller which turns it on when there is enough solar energy to heat the water.

A pump and a controller are not required in a thermosiphon system, in which the tank is mounted above the collector to provide a natural gravity flow of water. Widely used in Florida a few decades ago, thermosiphon systems are regaining some of their popularity.

Collectors ideally should be mounted on an unshaded area of a south-facing roof, but they can also be mounted on the ground. Collectors can face up to 45 degrees east or west of south without a significant decrease in performance. They should be mounted parallel to the roof for all shingle and tile roofs in Florida, which generally have pitches greater than 3 in 12 (i.e., 14°).

However, for flat roofs and very low-sloping roofs, collectors should be tilted at an angle (to the horizontal) that is approximately equal in degrees to the local latitude--Florida latitudes vary between 25° (in the Keys) and 31° (northern border). Tilting the collector at an angle up to 15° greater than latitude will increase winter performance, which may be desirable in most cases.

For some building designs, mounting of collectors to south-facing vertical or near-vertical surfaces may be considered. Awning-type mountings (at tilt angles approximately equal to local latitude) have been used and can serve a dual purpose by providing shading for window or door areas exposed to sunlight.

Question Two
Are solar water heaters reliable? What about maintenance?

Properly designed systems are reliable; glass-covered collectors can perform well for more than 20 years. Plastic covers may require replacement in less than 20 years, depending on the plastic material. Controllers, like other electronic devices, may require servicing during the life of the equipment, and the pump and water tank may have to be replaced in about 10 years. But since conventional water heaters have the same expected lifetime, water tank replacement costs are not regarded as unique to solar energy systems. Normal maintenance consists of checking pipe insulation, roof penetrations and collector mounting, and periodic pump lubrication and tank flushing. The latter also is recommended for conventional water heating systems.

Question Three
What size system do I need?

For Florida residences with a dishwasher and an automatic clothes washer, a good rule of thumb is 10 to 15 square feet of single-cover, flat-black collector area per person and 20 gallons of water storage per person. Thus, for a family of four, 40 to 60 square feet of collector and an 82 gallon storage tank are recommended.

Question Four
How much do I save?

Monthly savings will depend on the amount of hot water usage, solar energy system size, and type and price of fuel used for backup. For a family of four with washer and dishwasher, energy costs currently average around $20 per month for electrically heated water.

In an all-electric home, water heating accounts for between 15 percent and 25 percent of the utility bill. A solar water heater can save between 50 percent and 75 percent of the hot water portion of the utility bill or $10-$15 per month for a family of four *if the backup is always kept on at about 140° F.* A solar water heater can save even more if you turn off the backup and make do with a little less hot water. During the summer months, when hot water demands are lower and the sun shines longer, most solar owners turn off the backup and still get plenty of hot water. Solar owners should experiment with the backup element breaker switch turned off to see how well they can get along with solar alone.

Electricity savings should approximate $2 to $3 per month for every 10 square feet of collector. Remember, these are rough estimates only. As electricity and other fuel prices go up, savings will increase.

Question Five
What are some other ways to save on water heating bills?

The best way is to use less hot water. Install flow restricters on showerheads. Wash clothes in cold or warm water instead of hot water when sterilizing temperatures are not required. Most clothes can be washed satisfactorily in a warm wash, cold rinse cycle.

Reduce the hot water tank thermostat setting to 130° F or lower. Wrap extra insulation around the tank (insulating kits are available), and insulate the hot water outlet line and cold water inlet line for a few feet near the tank. (These conservation measures are effective whether or not a solar water heater is installed.)

Installing an automatic timer which allows the heating element to come on only during certain hours of the day may be cost-effective if the family needs hot water primarily for a few hours during the day. In a one-tank solar system it is a good idea to have the backup controlled by a timer to prevent it from coming on during daylight hours. Timers may be very attractive where peak-load pricing of electricity is available. In peak-load pricing, electricity used during certain hours of the day is priced at a much lower rate than that used during other hours. This pricing technique is being evaluated by many companies and has been introduced by at least one in Florida.

Question Six
Do I have to change my hot water use habits to use a solar water heater?

Not necessarily, because solar water heaters usually are installed with a backup heating system to ensure hot water at all times. However, to maximize solar utilization (maximize savings) the heaviest hot water usage should be in the afternoon and evening. Also, solar utilization will be more effective if hot water use is spread more evenly over the week. For instance, instead of washing seven loads of clothes in a single day, washing one load each day will increase solar utilization—i.e., reduce the amount of backup energy required.

Question Seven
How much does a solar water heater cost? Is it economical?

The cost varies widely. A person familiar with plumbing, roofing and electrical work can build a solar collector and install it on an existing conventional system for about $500 (cost of materials, pump and controller). Factory built solar collectors cost $10 to $25 per square foot, pumps and controls $150 to $[illegible]0, and installation typically costs $[illegible]. The cost of installing on a tile roof that faces east, west or north may be much higher. The cost of a dealer installed system currently varies between $1,400 and $2,[illegible] and may be higher. Solar water heating is already economically competitive with electric and propane water heating. Although it is not yet economically competitive with natural gas or fuel oil, it may soon become so as prices for those fuels are deregulated or shortages occur.

Question Eight
Does the government offer any solar use financial incentives?

While there are no current residential [illegible] programs, the following federal personal income tax credit is available to home owners who install solar space heating, cooling, or [illegible] water heating (pool heating not eligible):

Eq[illegible] [illegible] from January 1, 1980, through [illegible] first $1[illegible] spent [illegible] [illegible]

In addition, the State of Florida exempts solar systems from the state sales tax and from property tax.

Question Nine
How do I finance a solar water heater?

The best way to buy a solar energy system is to finance it as a part of the home mortgage. In such long-term loans (20 years or more) the monthly savings will be greater than the monthly payments. Example: monthly payments on a $1,[illegible] financed as an addition to a 30-year, 12 percent mortgage will be $12.35. This compares favorably with the expected savings on fuel bills of $10 to $15 a month now and greater later (see Question Four).

If you are buying an existing house with a new FHA mortgage you may be able to include a new solar water heater in the mortgage; check with your local FHA office. Also, many Florida lending institutions now offer short-term loans for solar systems in existing homes, based on the applicant's personal credit rating. The FSEC Public Information Office maintains a listing of financial institutions willing to make solar loans.

Question Ten
Should I buy a solar water heater now or wait for prices to come down?

The major costs of a solar system are in materials and labor, both of which are continuously rising. For this reason, prices of solar water heaters are not expected to drop as they did, for example, with electronic calculators. You should invest now if you can get a favorable loan or have ready cash.

Question Eleven
Where can I buy a system?

There are numerous firms in Florida installing solar water heaters, most of which are listed in the telephone book or advertised in local papers. A *Florida Solar Industry Directory* and consumer information may be ordered from the Center's Public Information Office.

Question Twelve
What kind of solar collector should I buy?

Flat-plate collectors should be used for solar domestic water heating. They are mounted in a fixed position throughout the year and do not track the sun as do some collectors used for high temperature solar applications. The frame of a flat-plate collector is a metal, wood or fiberglass box 2 to 4 feet wide, 4 to 12 feet long, and 4 to 8 inches thick. It contains a black-painted absorber plate for absorbing the sun's energy, which is transferred to water flowing through tubes soldered or tightly clamped to the absorber plate or which may be an integral part of the plate.

To reduce heat losses, a collector must have insulation behind the absorber plate and a transparent cover on the front facing the sun. Some insulation inside the box is also desirable.

Double cover plates are generally not economical in Florida, although they are widely used in the northern United States. The best cover material is [illegible]able-strength or tempered water white glass of low iron content. Iron content may be judged by viewing a cut or broken edge: low iron glass appears blue, water white has no color, and high iron glass appears green. Many manufacturers are using plastics rather than glass because they are lighter, less likely to break, easier to work with, and usually less expensive. Plastic covered collectors in general are slightly less efficient. However, collector performance varies widely and some plastic covered collectors perform better than some glass covered [illegible] (see FSEC Thermal Performance Ratings).

The absorber plate is usually coated with a flat black paint, and most of these paints have been proven [illegible] [illegible]ble and perform quite well [illegible]

adopted black chrome or nickel called selective surface coatings as opposed to non-selective coatings (flat-black paints) which perform better but may be less durable

The tubing in *potable water collectors* should be made of copper and flow passage diameter and flow area should be sufficient to reduce the effect of scale formation in the tubes The collector box should be designed to last 20 to 30 years

Question Thirteen
How can I protect myself from unscrupulous solar energy equipment salesmen and poor quality systems?

In a relatively new and fast-growing field like solar energy there may be a few dishonest firms Ask the equipment salesman for a list of customers and talk to them Also check into the firm s reputation The contract with your installer is very important because that is the person you will call first in case of trouble Ask about the warranty offered and read it carefully It is desirable to have a double warranty one from the installer and one from the solar manufacturer

Cost effectiveness and reliability are prime concerns when buying solar collectors To aid Floridians in this respect the Florida Solar Energy Center conducts a state-mandated program of collector testing and certification

All collectors now sold in the state of Florida should bear the Center s label as shown in Figure 1 Three performance ratings are given and the middle rating marked Intermediate Temperature should be used to compare collectors for domestic water heating Buy a certified collector supplying the most intermediate temperature Btu per dollar of installed cost A list of FSEC certified collectors and their ratings can be obtained free of charge from the FSEC Public Information Office

FSEC now conducts a state-mandated program of standards promulgated for solar domestic hot water and solar swimming pool heating systems It is up to the building inspectors and local officials to enforce these standards For more information contact the FSEC Standards Office

Question Fourteen
How do I install a solar water heater?

Installing a solar water heater requires plumbing roofing and electrical skills which are usually beyond the ability of an average homeowner

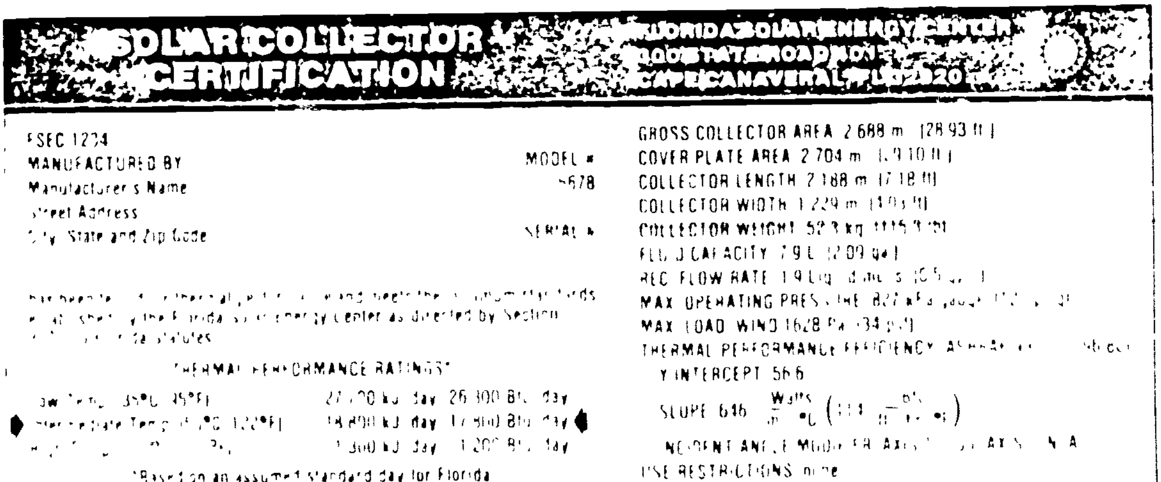
Figure 2 illustrates the plumbing and operational principles of a solar water heater using a *four outlet solar hot water tank with an electric backup* This type is suitable for new installations or when one decides to discard the existing electric water heater which is normally undersized for solar applications--i e cannot hold 20 gallons of water per person However existing two-outlet water heaters can be modified for solar use a procedure described in *Modifying Storage Tanks To Improve System Efficiency (FSEC IN 10 81)* available from the Center

The hot water tank shown in Figure 2 differs from conventional tanks in that it has no lower electric element and there are two outlets on the side in addition to the usual two outlets on the top The side outlets are connected to the collectors as shown All plumbing to and from the collectors must be well *insulated* The number of collectors used may vary (see Question Three)

Question Fifteen
How does the solar water heater work?

In the morning as sunshine strikes the collector the water in it is heated When the collector water becomes about 15 F warmer than that at the bottom of the storage tank as sensed by sensors S-2 in the collector and S-1 in the tank the differential controller activates the circulating pump which moves water from the tank through the collector and back into the tank Typically the water gains 10 F in a single pass through the collector so the water you get at the tap has been circulated through the collector several times

This process continues as long as the water temperature at the collector outlet is about 3 F higher than that in the bottom of the tank If the temperature difference decreases further the controller automatically shuts off the pump A backup electric element heats the water during periods of insufficient sunshine or high hot water demand A check valve prevents heat loss which could


SOLAR COLLECTOR CERTIFICATION
FLORIDA SOLAR ENERGY CENTER
300 STATE ROAD 401
CAPE CANAVERAL, FL 32920

FSEC 1234
MANUFACTURED BY
Manufacturer s Name
Street Address
City State and Zip Code

MODEL # 5678
SERIAL #

GROSS COLLECTOR AREA 2 688 m (28 93 ft)
COVER PLATE AREA 2 704 m
COLLECTOR LENGTH 2 188 m (7 18 ft)
COLLECTOR WIDTH 1 229 m
COLLECTOR WEIGHT 52 3 kg
FLUID CAPACITY 7 9 L (2 09 gal)
REC FLOW RATE 1 9 L
MAX OPERATING PRESSURE 827 kPa
MAX LOAD WIND 1628 Pa (34 psf)
THERMAL PERFORMANCE EFFICIENCY
Y INTERCEPT 56 6
SLOPE 6 46 Watts
USE RESTRICTIONS none

THERMAL PERFORMANCE RATINGS*
Low Temp (35°C 95°F) 27 700 kJ day 26 300 Btu day
Intermediate Temp (50°C 122°F) 18 800 kJ day 17 800 Btu day
*Based on an assumed standard day for Florida

Figure 1. The FSEC Collector Certification Label

Use "Intermediate Temperature" rating to compare collectors for domestic water heating applications.

occur if hot water were allowed to circulate in the opposite direction--a possibility when the pump is off. The pump consumes only a small amount of electricity, around $3 to $7 worth per year. An air vent prevents flow stoppage by air bubbles. Solar-heated water can reach scalding temperatures in the tank (160 - 170 F); therefore a mixing valve should be installed to limit outlet temperature to 140 F or less by adding cold water to the hot.

Since mechanical check valves often get stuck open by debris or scales in the water, periodic maintenance may be necessary to prevent nighttime thermosiphoning of hot tank water to the cool collector. The thermosiphon test is simple: touch the collector lines at night--if at a point three or four feet away from the tank the return line to the tank feels hotter than the other line, the system is thermosiphoning. Nighttime thermosiphoning can be prevented by using a motorized ball valve (a solenoid valve) instead of the check valve. This ball valve is electrically activated to open only while the pump is running.

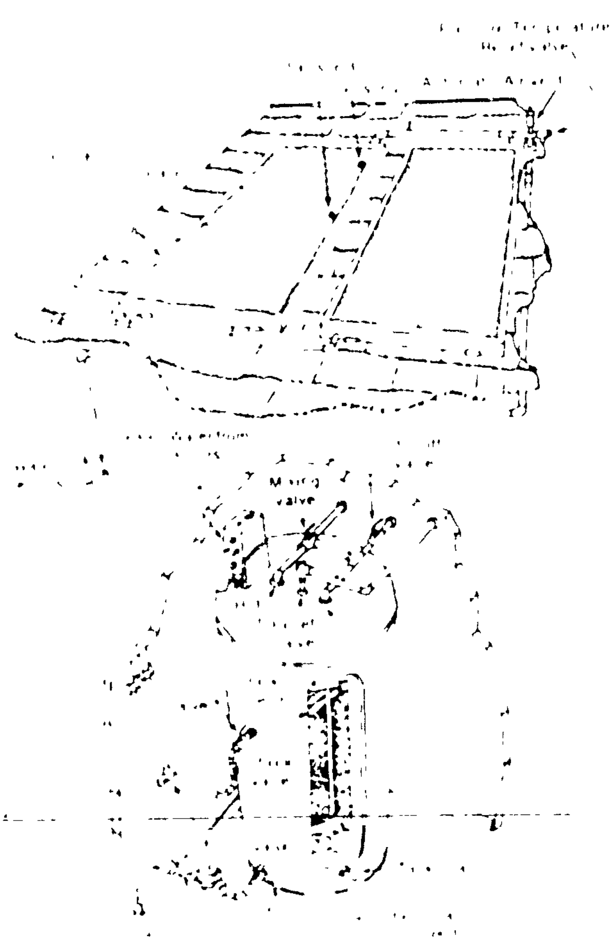


Figure 2. A Solar Water Heating System

Malfunction has been a problem with some differential controllers. Other types are available, such as timers, snap switches, or photovoltaic panels which power a DC pump directly with sunlight-converted electricity. Differential controllers are improving in quality, and all control strategies should perform about equally well if properly designed and installed.

Question Sixteen
What About Freeze Protection?

Freeze protection is an absolute must for any solar system, because a single freeze can destroy a collector. Even in Miami, collector tubes have frozen and burst during hard winters such as occurred in January 1977.

One method of automatic freeze protection is achieved by hot water circulation (Figure 2). When the temperature drops below 35 F, it is sensed by the freeze sensor S-3, which activates the pump to circulate hot tank water through the collectors. In some systems the sensor S-2 can also serve as the freeze sensor, eliminating the need for a separate S-3. A second level of protection, required in this system in the event of a power failure, is provided by the drain valves. During hard-freeze forecasts, valves V-1 and V-2 can be shut off manually and drains D-1 and D-2 opened manually to drain the collectors. Manual protection alone may be adequate for homeowners in Florida areas where hard freezes are rare.

There are two other types of solar water heaters which can afford better freeze protection but at added cost. These are known as the antifreeze and the automatic drain-down or drain-back systems, which are used extensively in the northern United States and are also suitable for Florida.

In the antifreeze system, a glycol solution (similar to that used in automobiles) instead of water is circulated through the collector (sometimes a silicone fluid is used). A heat exchanger between the collector and storage tank or inside the tank transfers heat from the antifreeze to the water. Although this system is usually more expensive and less efficient than direct water systems, it provides much better automatic freeze protection year round and remains free of scaling problems inside the collector tubes. However, glycol systems need periodic fluid replacement, just as automobile radiators do. Over a number of years, scaling can severely degrade the performance of direct systems, especially those with collector tubes narrower than ½ inside diameter.

Drain-down systems normally use electrically-operated solenoid valves which automatically drain the water from the collector during freezing temperatures. In some other systems, the collector is automatically drained whenever the circulating pump stops. With careful design, drain-down systems can be fail safe and cost-effective.

FSEC-EN-5-80
July 1980
Revised, November 1981
Florida Solar Energy Center
300 State Road 401 Cape Canaveral, Florida 32920

21. USING ENERGYGUIDE LABELS FOR COMPARISON SHOPPING

OBJECTIVES: K. 51. Identify some benefits of comparison shopping.

K. 52. Identify how a consumer choice involves the giving up of other alternatives.

MATERIALS: EnergyGuide Labels

ACTIVITIES:

If you have to choose between two appliances with the same features, capacities, and price, but with different annual energy costs, then obviously you are better off buying the one with the lower annual energy cost (the more energy efficient model). You can simply look at the big number on each label, see which is lower, and purchase that model.

However, the purchase price of the energy efficient model may be higher than the price of the standard model. (This is because extra insulation and more efficient motors often cost more.) But think again: the lower energy cost of the energy efficient model will usually make up for its higher purchase price. The question, then, is how to figure out which model will cost you less in the long run

Figure 1 is a worksheet that shows you how to use the EnergyGuide Label to decide whether you are better off buying a model with a higher purchase price but lower annual energy cost. For example, you can use the worksheet to compare the two refrigerator-freezers whose labels and prices are provided in Figure 2.

First, you need to fill in the answers to the questions on the top half of the worksheet.

1. Are the appliances comparable in size and features? As you recall, to find the capacity of the model, look just above the word "EnergyGuide" on the left hand side of the label. The refrigerators in this example are both about 17 cubic feet, and the features given on the top right side of the labels are the same, so the answer to the first question is "yes."

2. What is the purchase price of the energy efficient model? What is the price of the standard model? The energy efficient model is the one with the lower yearly energy cost (or, in the case of air conditioners, the higher energy efficiency rating). As you can see in Figure 2, the label on the Model A shows an average yearly cost of $51; the label on the Model B, a cost of $70. In this example, therefore, Model A is the more energy efficient appliance, and Model B is the standard model. Now look at the price tags of the two refrigerators. The energy efficient model is priced at $545 and the standard model at $485. (If you wanted to, you could also add sales tax and delivery charges, if any, to the price of each model.) Which, then, has the lower total cost? This depends on...

3. How often will you use the product? This question does not apply to refrigerators, freezers, and water heaters, which run continuously. However, you will need to answer this question for clothes washers, dishwashers, and room air conditioners, since these are appliances that some people use often but others use seldom.

4. What is your local energy rate? Assume, for this example, that your local electricity rate is 5.4¢/kWh. Because the grid on the label gives costs in intervals of 2¢, you will need to round off the rate--in this case, to 6¢/kWh.

   How much will each model cost you to run annually, based on your local energy rate? If you look at 6¢/kWh on the cost grids in Figure 1 you can see that the standard model will cost you approximately $85 per year and the energy efficient model will cost you approximately $62 per year to run.

5. How long do you expect to keep the appliance? The average life of a refrigerator-freezer is appoximately 15 years as shown in the table below. However, assume for this example that you will move in 10 years and leave the appliance behind.

AVERAGE LIFE EXPECTANCY OF NEW APPLIANCES

Appliance	Expected lifetime (years)
Refrigerators and refrigerator-freezers	15
Freezers	18-20
Dishwashers	11
Clothes washers	11
Water heaters	10-12
Room air conditioners	12-15
Furnaces	20

Once you have answered these five questions, you can figure out whether you are better off buying the more energy efficient appliance by performing the calculations on the bottom half of the worksheet in.

Step 1. As shown on the worksheet in Figure 1, you first need to calculate the difference in purchase price between the two appliances by subtracting the cost of the standard model ($485) from the cost of the more energy efficient model ($545). The price difference in this case is $60.

Step 2. Next, estimate the amount of money you will save each year with the more energy efficient model by subtracting the operating cost of the energy efficient model from the yearly operating cost of the standard model. In this example, since refrigerator-freezers run continuously, you just need to know the local energy rate in order to identify Model A and Model B's yearly operating cost. Thus, at a 6¢/kWh rate, Model A's yearly operating cost would be $62, Model B's yearly operating cost would be $85, and your yearly savings would be $23 ($85-$62=$23).

Step 3. You can then calculate the total amount of money you will save in operating costs over the years with the more energy efficient appliance by multiplying the yearly cost by the number of years you expect to keep the appliance (10 years). This gives you the total operating costs for the life of the appliances: Model A's total operating cost would be $620, Model B's would be $850. The difference between the two applicances' total operating costs gives the total savings in operating cost, $230.

Step 4. The total cost to you is the purchase price plus the total operating cost over the life of the appliance. Add the purchase price and total operating cost for Model A ($545+$620=$1165) and for Model B ($485+$850=$1335) and find the difference or total savings. Thus, the total savings in this example is $170 over 10 years, that is, by paying an extra $60, you can save a net $170 in energy costs if you keep the appliance for 10 years.

Step 5. Finally you can figure out how soon you will recover the extra $60 you have to pay for the more energy efficient appliance by dividing the price difference ($60) by the annual energy cost savings ($23). In this case, it would take you about 2-1/2 years to break even with the higher priced but more efficient model.

In summary, you can use the energy cost information on the label to determine:

- which appliance costs less to run
- whether you are better off buying an appliance with a higher initial purchase price but lower annual energy cost

Now you try it on your own. You can compare the two room air conditioners or dishwashers whose labels and prices are provided, or, better yet, compare two you find in the marketplace. But remember: with clothes washers, dishwashers, and room air conditioners, you will need to know both the local energy r. used (expressed in loads per week or yearly hours of use) before you can identify their yearly operating costs. Once you know this, do the same calculation as you did with Models A and B to determine the total cost savings.

Figure 1.

HOW TO FIGURE WHETHER THE ENERGY EFFICIENT MODEL IS A BETTER BUY FOR YOU

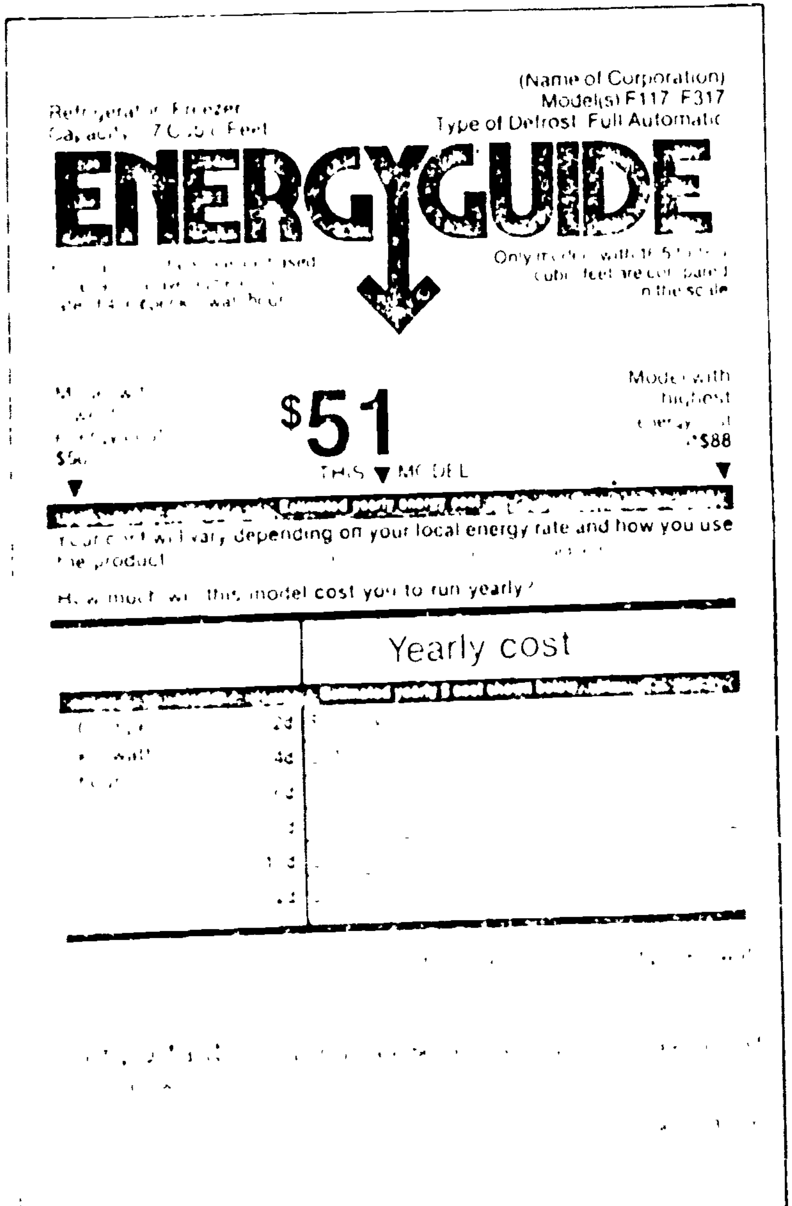
		Model B Standard Model	Model A Energy-Efficient Model	Difference
Step 1	Purchase Price	$___	$___	$___
Step 2	Yearly Cost (from appliance label)	$___	$___	$___
Step 3	How many years do you expect to keep it?	___yrs	___yrs	0
	Total Operating Cost (Multiply Yearly Cost by number of years you will keep it)	$___	$___	$___
Step 4	Total cost to you (Add Purchase Price and Total Operating Price)	$___	$___	$___

Step 5 To figure how long it will take to recover the extra cost of the energy efficient model, divide the difference in price from line 1 by the difference in yearly operating cost from line 2

Difference in purchase price − Difference in yearly cost = Years to Recover

$___ − $___ = ___ yrs

MODEL A
Cost: $545.00


(Name of Corporation)
Model(s) F117 F317
Type of Defrost Full Automatic

ENERGYGUIDE

Only models with ... cubic feet are compared in the scale

$51

THIS MODEL

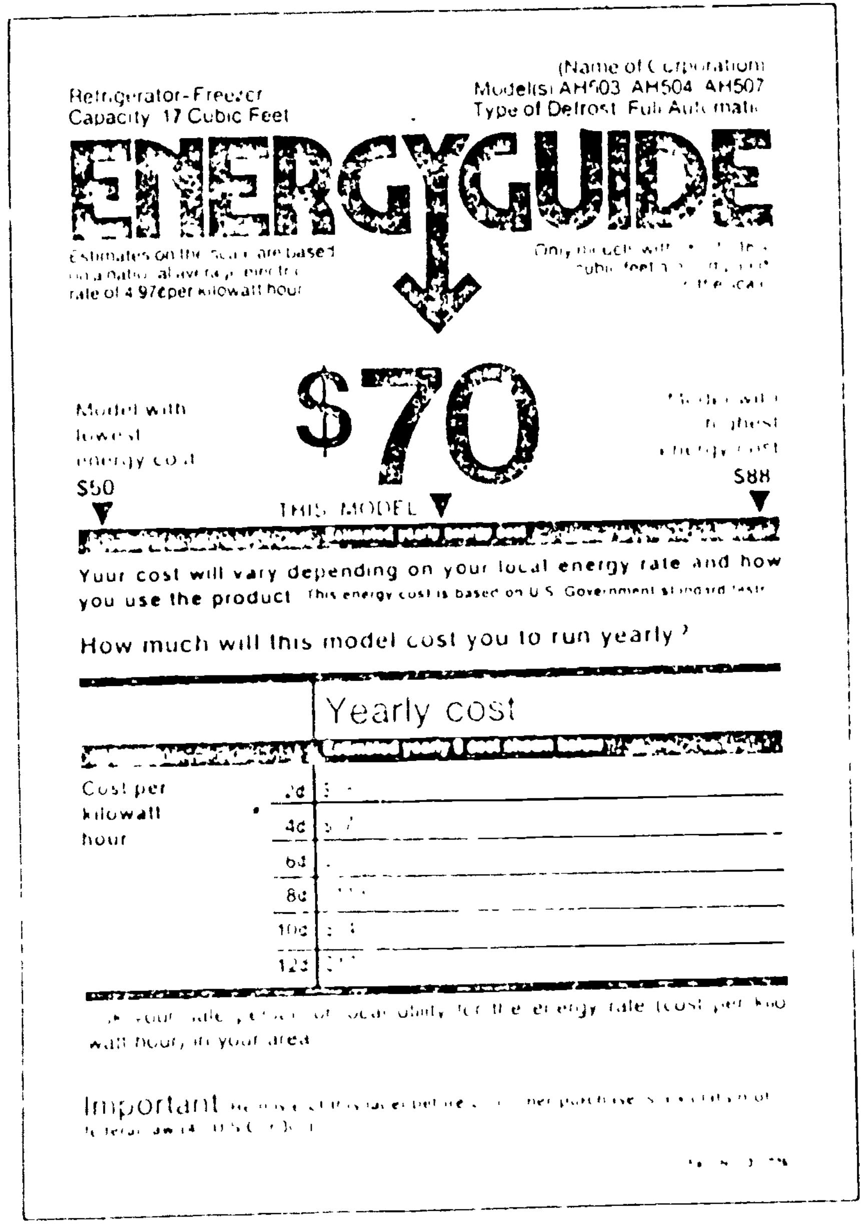
$88

Your cost will vary depending on your local energy rate and how you use the product

How much will this model cost you to run yearly?

Yearly cost

MODEL B
Cost: $485.00


(Name of Corporation)
Model(s) AH503 AH504 AH507
Type of Defrost Full Automatic

Refrigerator-Freezer
Capacity 17 Cubic Feet

ENERGYGUIDE

Estimates on the scale are based on a national average electric rate of 4.97¢ per kilowatt hour

Model with lowest energy cost
$50

$70

THIS MODEL

Model with highest energy cost
$88

Your cost will vary depending on your local energy rate and how you use the product. This energy cost is based on U.S. Government standard tests.

How much will this model cost you to run yearly?

Yearly cost

Cost per kilowatt hour	
2¢	
4¢	
6¢	
8¢	
10¢	
12¢	

Ask your utility company or local utility for the energy rate (cost per kilowatt hour) in your area

Important

Figure 2.

22. SUNSHINE INN

OBJECTIVES: M 60. Define savings as income which is not spent for consumer goods or services but is set aside for future use.

M. 61. Name reasons why people save.

MATERIALS: None

ACTIVITIES:

Problem: The owner of a small convenience store has been noticing that her electric bill has been steadily rising. The store has a floor area of 1200 square feet and uses 6000 Watts of fluorescent lighting. The store is open from 7 AM to 11 PM.

A lighting engineer has informed her that by installing 8 skylights, each having an area of 8 square feet, that she will be able to keep her lights off for an average of 8 hours a day. In addition, while the lights are off, she will save 1000 Watts of air conditioning needed to remove the heat generated by the lights.

Electricity costs $.08 per kilowatt hour (kWh) and is expected to become more expensive.

Your job is to determine whether the skylights will be worth the investment.

Solution:

1. Call someone who installs skylights and find out what it would cost to install the 8 skylights. You may want to get more than one estimate.

2. Calculate the daily savings in electrical costs. A kW is 1000 Watts. The savings are given by:

   DAILY SAVINGS = (KW LIGHTING SAVED + KW A/C SAVED) X (HRS LIGHTS OFF PER DAY) X (ELECTRIC RATE)

3. Calculate the yearly savings in electrical costs.

   YEARLY SAVINGS = 365 X (DAILY SAVINGS)

4. Calculate how many days it will take to save enough money to pay for the skylights.

   $$\text{DAYS} = \frac{\text{SKYLIGHT COST}}{\text{DAILY SAVINGS}}$$

5. Calculate how many years it will take to save enough money to pay for the skylights.

   $$\text{YEARS} = \frac{\text{DAYS}}{365}$$

6. Calculate the approximate return on investment for the skylights.

$$\text{RETURN} = \frac{1}{\text{years}} \times 100$$

7. Find out the monthly payments if the money for the skylights is borrowed over a 20-year period at a 15% interest rate.

8. A fancier investment criteria is the internal rate of return. The formula is:

$$\frac{\text{SKYLIGHT COST}}{\text{YEARLY SAVINGS}} = r$$

This formula needs to be solved for r. The best way is to use a computer or a programmable calculator. When r is found, it is multiplied by 100 to express it in percent. The value of r is the amount of tax free interest which would have to be earned if the same money were invested in something other than the skylights. It takes into account the estimates that electrical rates will increase by 10% per year and that the skylights will last for 20 years.

9. Compare the monthly payments with the monthly savings in electricity.

23. SHADE TREES AS INVESTMENTS

OBJECTIVES: M. 62. Define personal investment as the purchase of an asset (with some degree of risk) for the purpose of earning future income.

MATERIALS: Student Handout: Landscaping to Save Energy

ACTIVITIES:

1. Discuss savings and investment within the context of a free enterprise system, including the freedom of consumers to look after and to promote their own best interests.

2. Explain how persons can invest money today, to save money tomorrow. Quote the famous Fram Oil Filter Commercial "You can pay me now, or pay me later." Give solar examples: Buy window awnings today, to save air conditioning bills later. Buy insulation now, to save heating bills later.

3. Have students read "Landscaping to Conserve Energy." Ask them how trees and plants are an investment. Ask them how this investment choice can save them money later; pay a return or profit.

4. With a local nurseryperson, have a team of students maximumize energy savings in a design for a local house, and minimumize the amount of money spent. Have them explain their design (s) to the class.

STUDENT HANDOUT

Landscaping to Conserve Energy

Robert Black *

It is not possible to control temperature, wind and other natural elements, but it is possible to modify the climate for better living. With proper selection and placement, plants can play a role in decreasing the energy required to keep your home comfortable during both winter and summer.

Trees, shrubs, vines and other plants protect your home from intense solar radiation, storms and blowing winds. Besides helping to reduce your home's fuel needs, plants help keep your home more dust-free and reduce noise from highways and other sources.

Add to this the beauty, permanence and homelike setting which attractive landscaping brings to your home and community. The returns in comfort and economy far outweigh the cost of planting and maintenance. And the time spent selecting and arranging plants around your home will pay dividends when your heating and cooling bills come due.

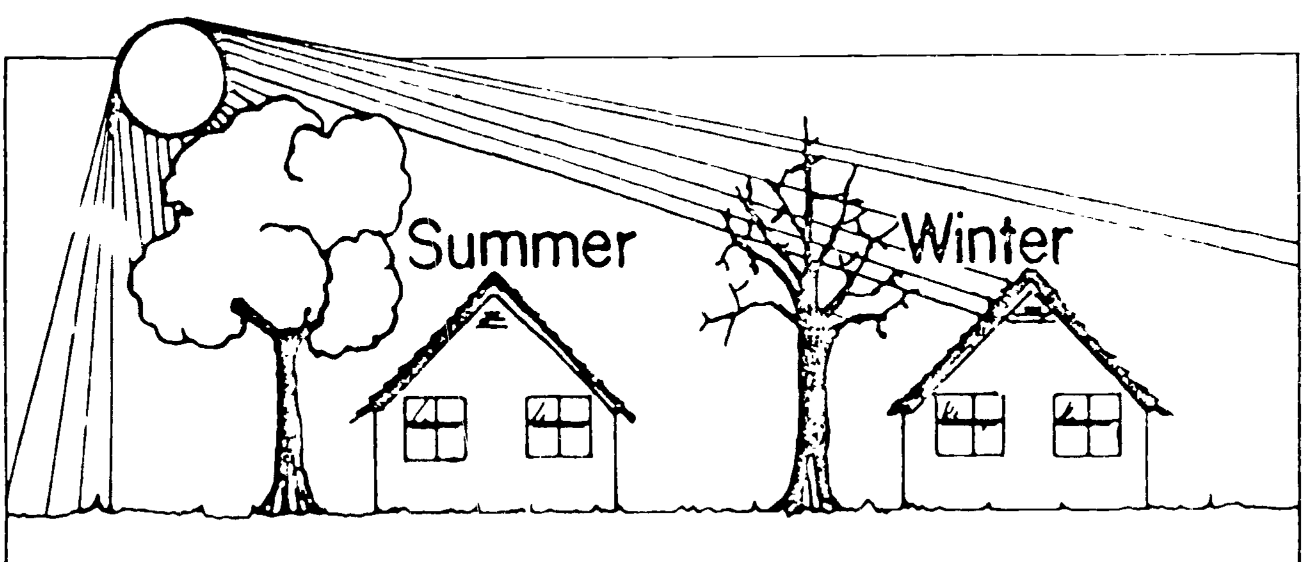
SHADE

Trees, vines and espaliered plants (plants trained to grow flat against walls or trellises) provide cooling shade for the walls, windows and roof of your home. With proper selection and planting, they can also allow the sun to warm your home in the winter.

Trees

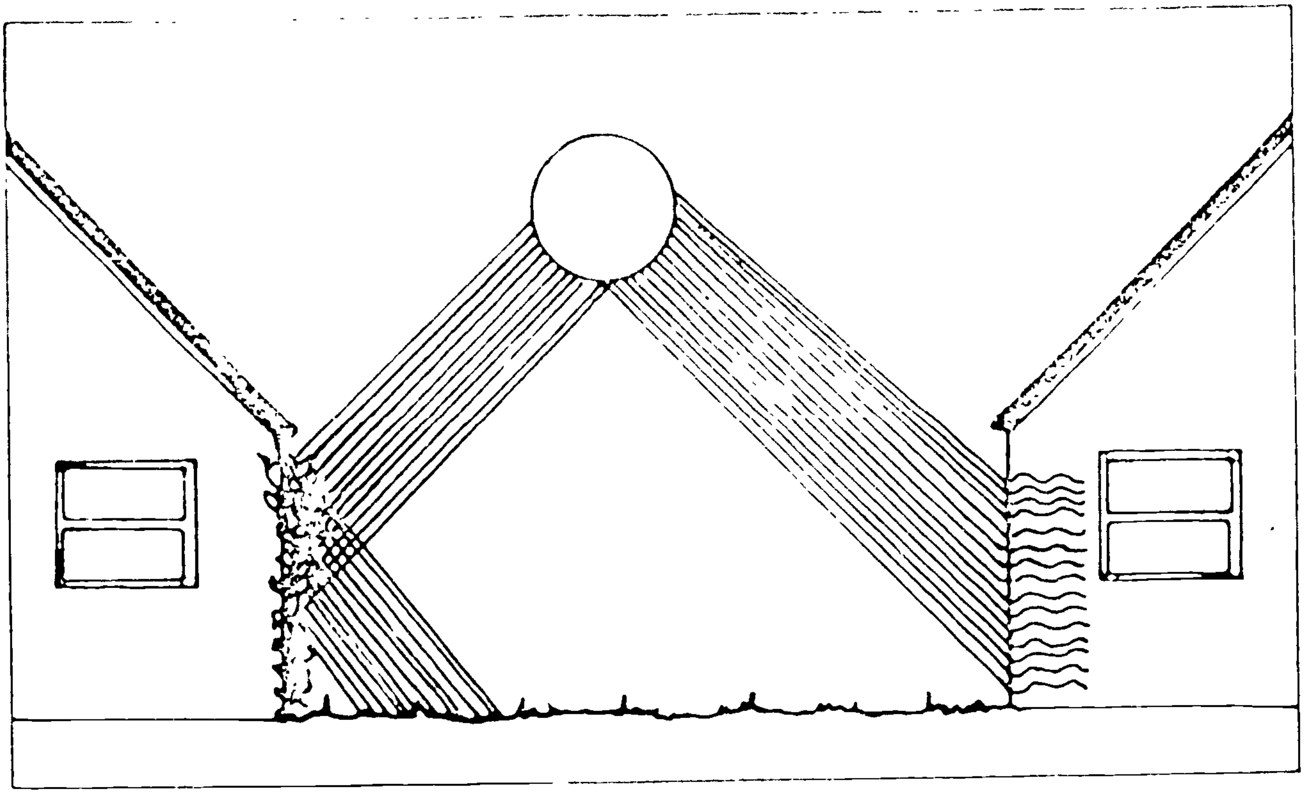
A tree planted on the west side of your home shields it from the hot afternoon sun in the summer, a tree on the east side shades the neighbor's house. Select deciduous trees because during the winter their bare limbs will allow the sun's rays to warm your home. An evergreen tree will provide year-round shade and may be more desirable in tropical climates.

To shade a roof or wall on a one-story house, plant medium to large trees as close as 15 to 20 feet from the side or 12 to 15 feet from the corner of the



Deciduous trees provide shade in the summer and allow the sun's rays to warm your home during the winter

*Robert Black is an Associate Professor and Ornamental Horticulturist, Institute of Food and Agricultural Sciences, University of Florida



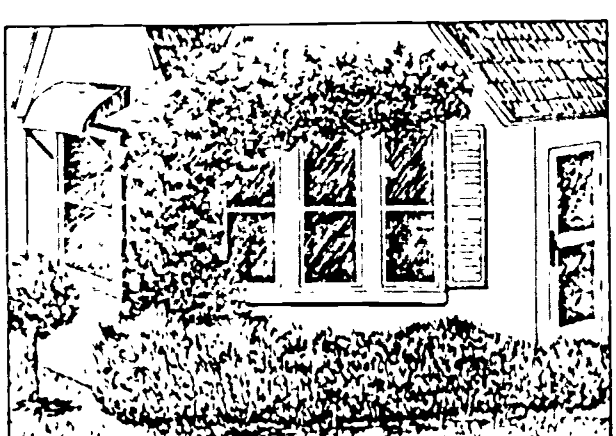
Vine covered walls insulate your home from the sun's hot rays.

building In order to obtain the maximum amount of shade, allow the canopy of the tree to extend over the roof

Espaliered Plants and Vines

Espaliered plants and vines grown on a bare exposed wall will act as heat control devices They insulate walls by absorbing and reflecting the sun's rays before they strike the wall

Vines can be grown on a trellis to shade windows which face south Deciduous vines, such as wisteria, will shade windows in the summer while permitting sunlight to enter your home in the winter



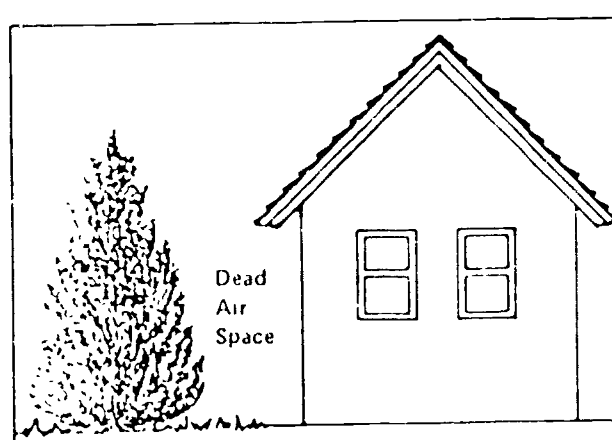
Deciduous vines will shade windows in the summer and allow sun light to enter your home during the winter.

WIND PROTECTION

The use of plants to control wind can reduce the cost of home heating and cooling

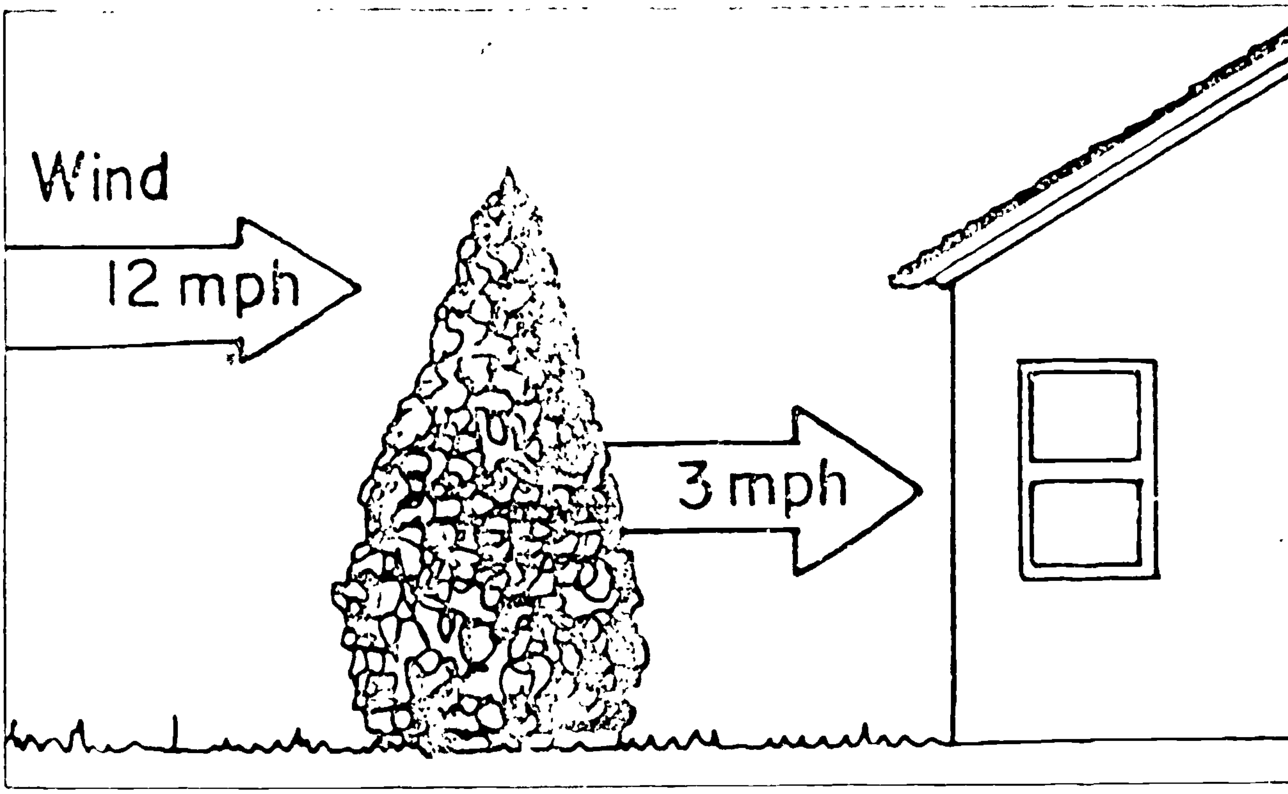
Dead Air Space

Placed in the right spot, evergreen trees and shrubs can shield your home from cold winter winds A row of evergreens placed next to a wall creates an area of "dead" air between the plants and the wall This still or dead air has much less cooling power than moving air. The temperature difference between the inside of your home and the outside dead air space

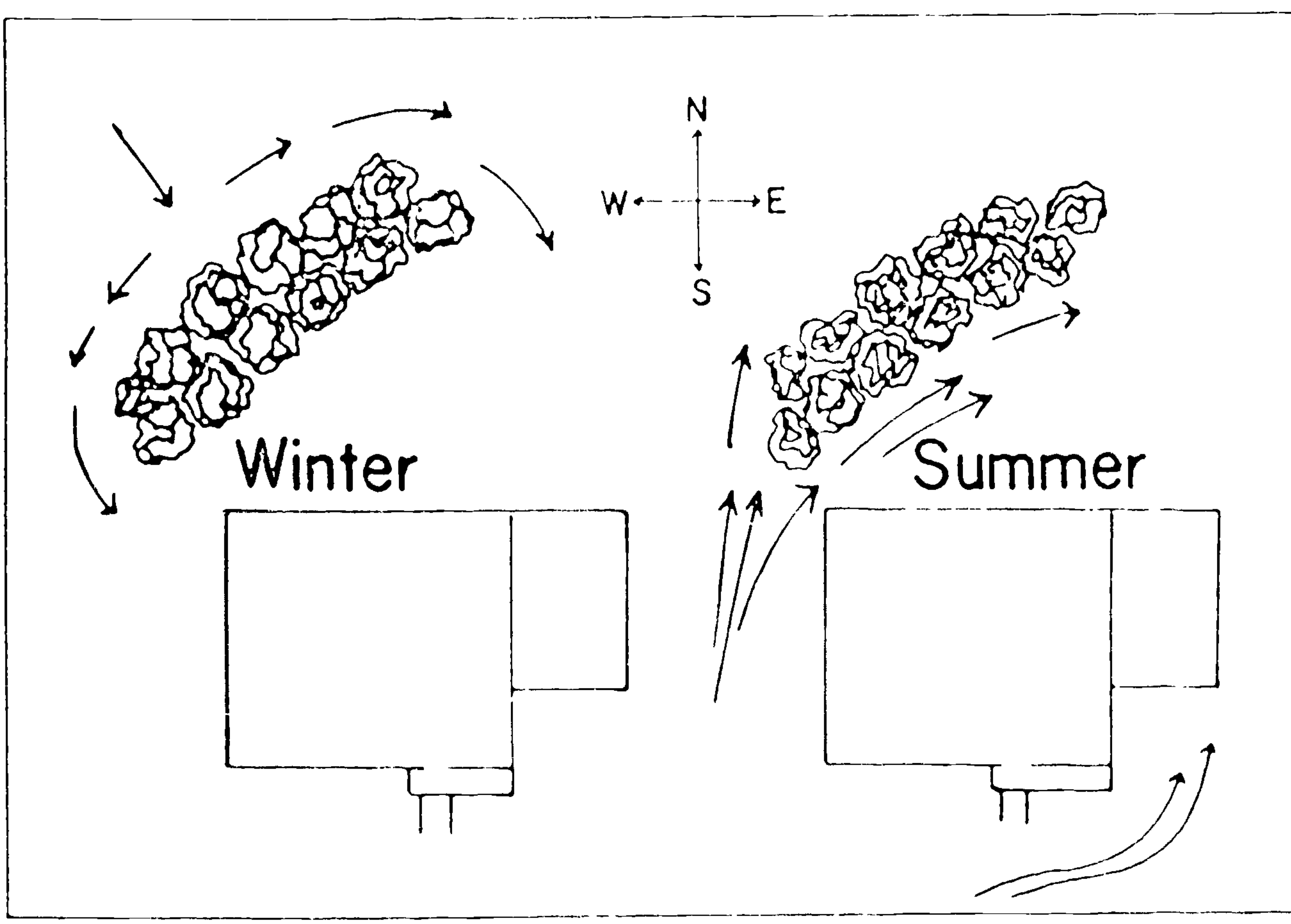


Evergreens next to a wall create a dead air space which helps insulate your home

74



Trees and shrubs will reduce wind velocities next to your home



Plants on the northwest side of your home may protect it from cold winter winds and also direct summer breezes around it

is reduced and held relatively constant, which greatly decreases the loss of heat through the walls.

In the summer, this dead air space will also insulate your home from hot air and help reduce your air conditioner's cooling load.

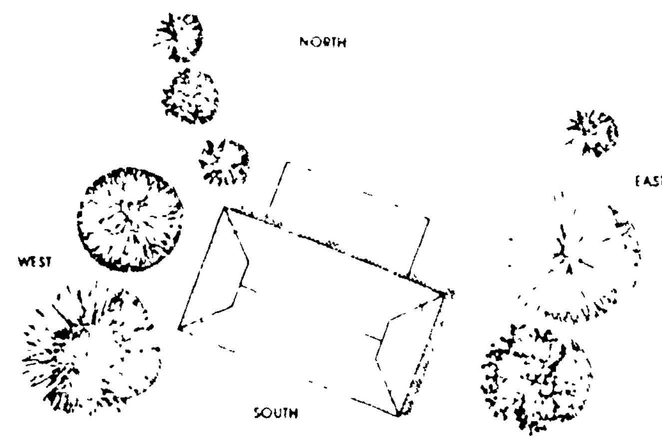
For this method of wind protection to function properly, the evergreens must be very dense and closely planted to form a solid wall.

Obstruction and Guidance

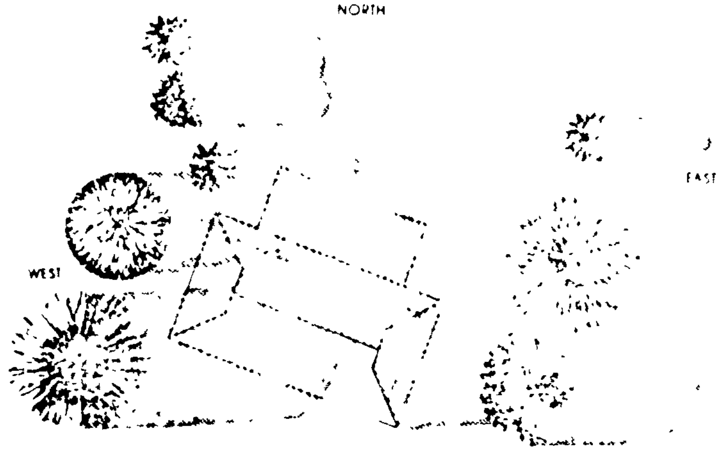
Trees and shrubs act as an obstructing barrier to reduce windspeed. Trees with dense foliage extending to the ground create a solid barrier while trees with sparse foliage and removed lower branches form an incomplete barrier. Coniferous evergreens that branch to the ground are the most effective year-round plants for wind control.

Plants not only slow down or deflect the wind for cold protection but they also can serve to guide the wind in a desired direction to provide a degree of coolness during the summer. For example, plants placed on the northwest side of your home may protect it from cold winter winds and also direct summer breezes around it.

For further information, contact your County Extension Office.



Three ... foot overhang will ... the noon sun from [illegible]



[illegible]

24. SOLAR INVESTMENT

OBJECTIVES: M 62. Define personal investment as the purchase of an asset (with some degree of risk) for the purpose of earning future income.

MATERIALS: Student Handout: Conservation Choices

ACTIVITIES:

1. Discuss the benefits and risks associated with choices for personal investments. Discuss the benefits and disadvantages associated with piggy banks, and options ranging to the stock market. Stress degree of risk, liquidity, and rate of return. Rates of return = annual savings divided by initial investment.

2. Consider energy conservation as an important option using the Rate of Return Nomograph on the student handout. For example, use the new cost of a $1,000 solar system (minus the 40% federal tax credit and any utility company rebate). If the savings in electricity amount to 25,000 kWh for a family of four and electricity costs 6¢ per kWh, the tax free return on investment would be 15%.

3. Have each student on a team choose a conservation investment (e.g. solar domestic water heater, solar pool heater, ceiling insulation, etc.) and call dealers to ascertain the prices. Have the results plotted on the nomograph and post the findings.

4. In an oral or written report have students orginize their findings on risks and rates of return on the investment option which they studied above.

5. Have the class come to these conclusions: Which investment studied offered the best rate of return?; Which offers the least risk?

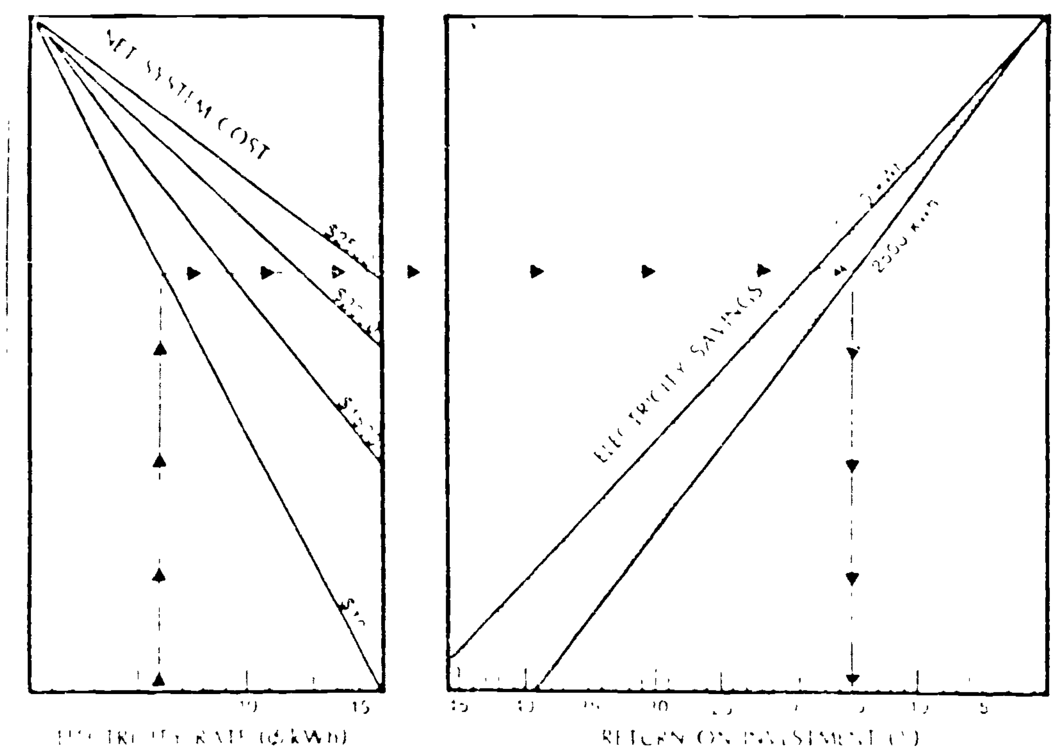
Extending the lesson: When a utility company builds a plant to make electricity, it is making an INVESTMENT It is building a capital good, and expects a reasonable rate of return (profit) on the investment. What is the current rate of return received by the utility company serving your region of Florida? Call them and ask, or call the Public Service Commission in Tallahassee.

STUDENT HANDOUT

CONSERVATION CHOICES

Type:	Net Installed Cost	Current Annual Saving
Water Heating Options:		
Heat Recovery Unit	$ 500	2000kWh
Dedicated Heat Pump	900	2340kWh
Solar System	1,500	3640kWh

Conservation Return on Investment Nomograph



25. RATIONAL CONSUMER BEHAVIOR

OBJECTIVES: O. 71. Identify factors to be considered when selecting a consumer good or service.

K. 53. Define impulse buying.

K. 54. Define planned buying.

MATERIALS: Student Handout: Comparison Shopping

ACTIVITIES:

1. Give an example of careless shopping. Ask students to share stories of careless shopping or impulse buying. Ask them what the consumer in each story should have done to be a careful or planned buyer of goods or services.

2. Ask students to list the factors on the chalkboard which they would evaluate before buying a solar water heater. Then, ask them to read the handout on Comparison Shopping. Do they want to add or subtract items from their list?

3. Have the students role-play an encounter between a "super" salesperson and an uninformed consumer.

COMPARISON SHOPPING

A solar energy system transaction involves a relatively large investment in time and money. Since it is a major purchase, comparison shopping is essential and will pay off in the long run. With the large number of manufacturers and distributors of solar equipment in Florida, the field from which to choose your system and installer may be larger than you might have guessed.

Prior to contacting the installer or manufacturer in your area, it is advisable to acquaint yourself with solar--how it works and what it can deliver. The sources listed below, and your local library, have publications available to aid you.

Public Information Office
Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920
(305) 783-0300

National Solar Heating and Cooling
Information Center
P.O. Box 1607
Rockville, MD 20850
(800) 523-2929

Once you feel comfortable with the principles involved in solar system operation, you should begin shopping. It may be preferable to contract with a local installer to ensure prompt post-installation service. This will also enable you to check the installer's local reputation more easily through some of his customers and by contacting local consumer protection offices and Better Business Bureaus. Since in many cases a local license is required of the installer, check with your city or county building department to determine what permits are involved. Also inquire into the installer's training--most important because faulty installations are primary causes of solar system problems.

Compare the products offered by the different companies. A system should be designed to last at least 20 years, however, some sensitive components may need periodic overhaul or replacement. The collector is the costliest part of the system, so be sure it is made of durable materials. Effective 1980, all solar systems sold or manufactured in Florida are **required** to be approved by FSEC. When you shop, ask to see the FSEC label or the Summary Information Sheet, each of which describes the collector test results. Full test results on individual collectors are available at cost from the FSEC Testing Office.

The thermal performance rating shown on the FSEC label and Summary Information Sheet can be used by the consumer to compare different collectors. (A list of these ratings for all certified collectors can be obtained from the FSEC Public Information Office.) DHW systems typically operate in the intermediate heat range; therefore, if that is what you are shopping for, compare **intermediate** ratings. Pool heating, on the other hand, is a low temperature process, so compare **low** temperature ratings if that is the kind of system you want.

Following are two methods of approximate comparison:

1. Estimate the amount of energy delivered per dollar of investment, which can be calculated by dividing the Btu/day value shown on the label by the total installed cost of the system, then multiplying the result by the number of collectors.
2. Estimate how much electricity and money a system using that collector will save. This can be done by dividing the kJ/day figure by 3 600 to find the daily energy savings in kilowatt hours, then multiplying that kwh savings by the number of collectors and the current price of electricity ($/kwh) to find the approximate daily money savings.

The Summary Information Sheet also includes a description of the collector and the collector model number. Verify that the collector shown to you is the one described on the sheet.

Since a collector's materials and size affect its cost, compare collectors of similar construction and size. The other components are relatively standardized and easily avail themselves to cost comparisons.

CERTIFICATION

This certifies that Solar Collector

XXX

by the Manufacturer

John Doe Solar Systems
100 Main Street
Anytown U.S.A. 00001

has been tested for thermal performance and meets the Minimum standards established by the Florida Solar Energy Center as directed by Section 377.705 Florida Statutes. This certification does not represent an endorsement of the product by the Florida Solar Energy Center or the state of Florida.

THERMAL PERFORMANCE RATING*

Low Temperature (35 C, 95 F)	21 000 kJ/day	20 000 Btu/day
Intermediate Temperature (50 C, 122 F)	16 000 kJ/day	15 000 Btu/day
High Temperature (100 C, 212 F)	3 000 kJ/day	3 000 Btu/day
Gross Collector Area	2.3 m²	25.0 ft²

*Rating is based on an assumed standard day for Florida.

A Florida Solar Energy Center Consumer Data Sheet which summarizes test results for this collector is available from the seller.

A test report may be obtained from the:

Florida Solar Energy Center
300 State Road 401
Cape Canaveral, Florida 32920

These do not represent minimum or maximum figures. They are provided merely as an illustration of the format of an FSEC label.

Obtain written contracts (or proposals) with estimates of total system cost, including installation charges. Compare the contracts, and do not sign one until you are satisfied with what you are buying. Ask the seller to include all provisions you may have discussed with him which you feel are important to your purchase decision. You are entitled under federal law to examine any written warranties offered with the product before you buy it. If your contract states there is a warranty, or if the dealer tells you there is a written warranty available, request a copy. Compare the warranties offered on different systems, but beware of inflated and excessive warranty coverage. A lifetime warranty is worthless if the business expires before your warranty does.

Request a copy of operating and maintenance instructions and be sure they are within your range of technical understanding. Compare them with those of other solar systems for comprehensiveness and simplicity. Along with mandatory equipment approval by FSEC, vendors will be required to submit operation and maintenance manuals to FSEC for approval.

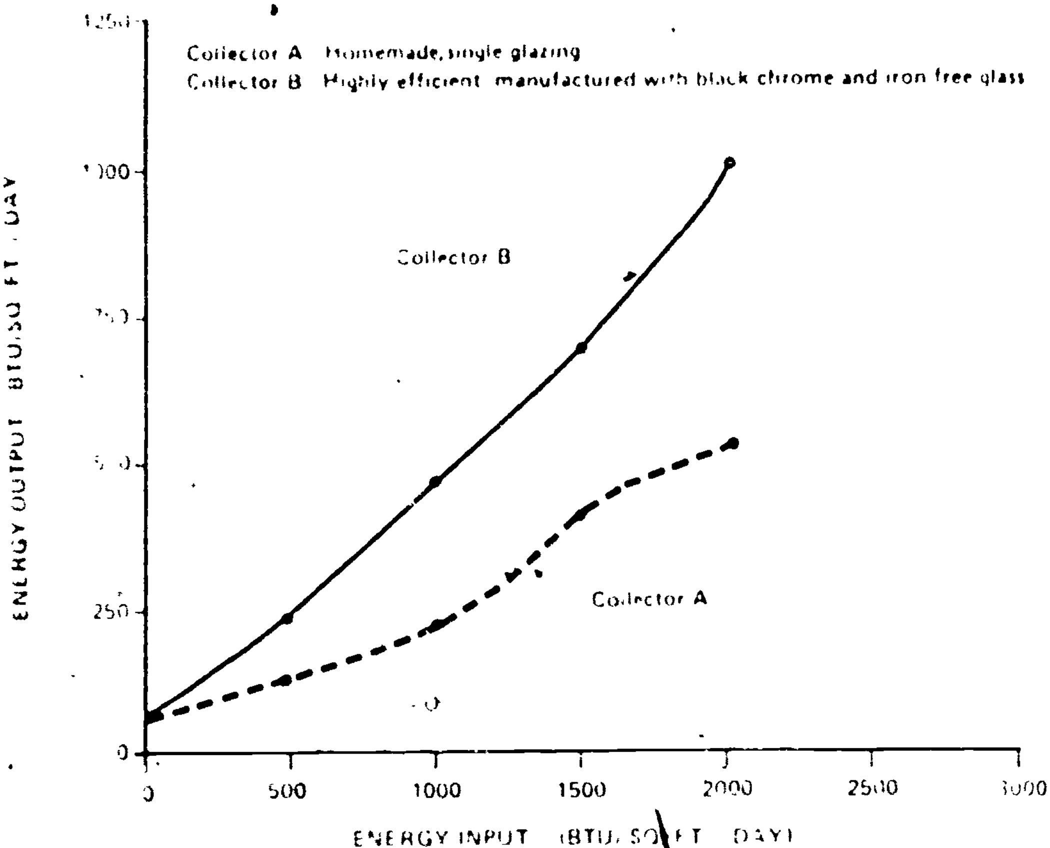
26. COMPARING SOLAR COLLECTORS

OBJECTIVE: O. 72. State reasons why a higher price does not necessarily indicate better quality.

MATERIALS: None

ACTIVITIES:

Study the graph showing the performance of two solar collectors.



Collector A was built by Kacie and her mother. They compared the efficiency of their collector with one that was tested at the Florida Solar Energy Center and made a graph of the results.

1. Complete the following table.

SOLAR ENERGY IN	COLLECTOR A		COLLECTOR B	
	BTU'S OUT	RATIO	BTU'S OUT	RATIO
500	100	.20	______	______
1000	______	______	450	.45
1500	______	______	______	______
2000	______	______	______	______

2. Make a bar graph comparing the ratio's of the two collectors. Which one is more efficient?

3. The homemade collector, A, cost about $300 to build; Collector B cost $850. Compare the collectors in terms of cost per delivered Btu.

   Assume a 1600 Btu/sq. ft./day solar day.
   Collector A ________ $/Btu Collector B ________ $/Btu

4. Which collector is the better bargain. Explain your choice using your calculations.

27. EXAMINING WARRANTIES

OBJECTIVES: P. 73 Name some of the basic provisions contained in warranties and guarantees.

MATERIALS: Student Handout: Warranties
Selected equipment and installation guarantees from manufacturers and contracting installers.

ACTIVITIES:

1. Read the student handout.

2. Imagine that you are purchasing a solar water heater. Select one based on any criterion you choose, such as design, appearance, cost, availability, advertising claims, or other factors. Read the manufacturer's guarantee or warranty and answer the following questions:

   a. Is the warranty full or limited?

   b. If the warranty is limited, list items not covered.

   c. What is the period of the warranty?

   d. List obligations the customer must meet.

   e. If any component fails within the period of the warranty, what must the customer do to obtain warranty service?

   f. Does the manufacturer require that any units be returned to the factory or service center for repair if the unit fails during the period of the warranty? If so, who pays for shipping?

   g. Does the manufacturer make any claim to indemnify or reimburse the purchase for loss if failure of any component in the system causes:

      (1) Water damage to the residence?
      Physical indury to occupants?

      (2) Damage to neighboring property or people?

      (3) Inconvenience of expense incurred due to having to obtain substitute equipment while repairs are being made?

      (4) Labor costs to make necessary repairs?

   h. Are any or all items covered by a pro-rated provision? If so, what items and what is the pro-rate provision?

   i. What provisions are made for freeze damage to the equipment?

   j. What provisions are made for protection against corrosion damage?

4. Compare the class's answers to part 3 and reassess "purchases" on basis study of warranties.

5. Rewrite a warranty to achieve one or more of the following objectives:

   a. Greater clarity or readability.

   b. Greater solar appeals.

   c. Better consumer protection.

   d. Less ambiguity.

WARRANTIES

As with any consumer product, the warranty for your solar energy system should be your assurance that the manufacturer and installer stand behind the system-- the terms of the warranty should indicate how strongly they will stand behind it. There are state and federal warranty laws designed to protect you.

The federal warranty law stipulates requirements where a **written** warranty is made available on a product. It defines a written warranty as a written affirmation of fact or a written promise for a specified period of time. For example, if your sales contract contains a clause which guarantees the installation and materials for a year, you have a written warranty. This triggers the requirements of the federal law. If you receive nothing in writing, the product is covered by an **implied** warranty. The law does not require that a written warranty be offered.

Written warranties are differentiated in the federal law as either **full** or **limited**, and the appropriate designation must appear on the warranty document. The full warranty is presumably better because it provides for the following:

— A defective product will be fixed (or replaced) free, including removal and reinstallation if necessary

— The product will be fixed within a reasonable time after you complain

— You will not have to do anything unreasonable to get warranty service (such as shipping the collector back to the factory)

— The warranty is good for anyone who owns the product during the warranty period

— If the product can't be fixed (or hasn't been after a reasonable number of tries) you get your choice of a new product or a refund

A full warranty does not necessarily cover the entire product. This is a crucial point in the solar system purchase, since the four major components are subject to warranty. A product can carry more than one written warranty and may have a full warranty on one component and a limited warranty on the others. Be sure you understand which parts each warranty covers and who (manufacturer, installer) is responsible for the warranty.

The limited warranty provides less protection than the full warranty. For example, a limited warranty may:

— Cover only parts, not labor

— Allow only a pro-rata refund on credit

— Require you to return a heavy product to the store for service

— Cover only the first purchaser

— Charge for handling

Regardless of how the warranty is labelled and how the provisions read the consumer should still be cautious--find out how long the vendor has been doing business and how he plans to back up the warranty. Beware of inflated warranties which promise everything, forever.

The implied warranty comes automatically with every sale even though it is not written out. First, the product you buy must be fit for its ordinary purpose --e.g., a solar water heater must heat your water. Second, if you buy a product relying on the seller's advice that it can be used for a special purpose, then this advice may create a warranty. However, all implied warranties may be avoided by the seller if he states that no warranty is given-- i.e., you buy it "as is." This is unacceptable in a solar transaction. Ask for at least a one-year warranty on the **installation** of the system in addition to any product warranties offered.

THE SALES CONTRACT

The contract should include a description of the system and components, including make and model number (and sizes where appropriate). If the contract makes any promises with respect to warranty, make sure you have received a copy of the warranty or information (such as a registration card) on how to obtain it. Avoid full payment in advance or before the system has been operational for a specific period by setting out a payment schedule in the contract.

In Florida, when the sales contract is signed away from the seller's place of business or involves a series of payments, a three-day cooling off period is permitted. A clause to this effect must be placed conspicuously in the contract.

Include a written statement in the contract stating that the company will respond to warranty calls within 10 days.

STUDENT HANDOUT

LIMITED WARRANTY — GULF THERMAL CORP., BOX 1273 • SARASOTA, FL. 33578 • (813) 957-0106

Gulf Thermal Corporation warrants its collectors to be manufactured to high standard with first commercial grades of materials from reliable sources used throughout. Each panel is pressure tested prior to shipment.

For a period of five (5) years from the date of installation, Gulf Thermal will repair or replace any defective parts including the absorber plate surface except as detailed in the following paragraph where such defect is the result of manufacturing error including cost of labor, materials, installation and shipment to installation site within the Continental U.S. port of embarkation for overseas sites.

When black chrome on nickel surface is specified, Gulf Thermal warrants the process to have been performed in a workmanlike manner in accordance with best industry practice by Olympic Plating Company, Canton, Ohio. As there are not yet ASTM standards established for solar application of the finish, Olympic and therefore Gulf Thermal are unable to issue a warranty on durability or range of continuing performance.

Gulf Thermal collectors are **not** warranted against glass breakage, damage due to freezing or copper damage due to unacceptable transfer fluid. In open systems water having a ph between 9.4 and 7.0 is acceptable. In closed systems, original fluid and any make-up fluid should consist of a mixture of Prestone II R manufactured by Union Carbide Corporation, or equivalent product **containing the necessary inhibitors** and distilled water if available, otherwise water testing from 9.4 to 7.0 ph. The mixture proportions should be as specified on the container for the climatic area.

The company's liability under this warranty shall be ended in the event of breakdown of the panel due to improper installation, reglazing, failure to replace broken glass promptly, or other breach of the enclosure allowing the intrusion of excessive moisture or other foreign material.

In the event of breakdown due to corrosion of the copper flow tubes when transfer fluid has been acceptable as above defined, Gulf Thermal warrants for the first year after completion of installation all costs of parts and labor required to remedy the defect including replacement of the absorber plate if necessary. For the next four (4) years Gulf Thermal will deliver to the site all parts needed to remedy the defect including a replacement absorber plate or entire new collector if necessary.

This warranty goes with the collector and is unaffected by change of ownership. Consequential damages as result of failure of this collector are not warranted.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. In order to obtain performance on any of the above warranty obligations, or should you have an unsolved problem concerning any Gulf Thermal product, please write or call collect the undersigned.

Dudley Slocum

Dudley Slocum
President

GULF THERMAL CORPORATION

P. O. Box 1273 • Sarasota, Florida 33578 • (813) 957-0106

28. SOLAR INSURANCE

OBJECTIVE: S. 79. Define insurance as the purchase of protection against loss.

MATERIALS: Student Handout: Checklist for Low Insurance Risk Solar Water Heaters

ACTIVITIES:

1. Define insurance, loss, and risk with the students. Ask them to list examples of each concept.

2. Read the Handout "Insurance Costs."

3. Using a sample, tell what homeowners insurance is.

4. Case situations:

   a. installed a $3000 solar hot water heater,

   b. their home's value increased by $3000 to $58,000,

   c. average repairs on the solar hot water heater are $15 per year.

   d. Should they buy increased homeowner's insurance? Why? Why not?

5. Using the handout as a reference, call a local insurance agent and find out what questions a homeowner would be asked when seeking insurance coverage for a solar water system.

STUDENT HANDOUT

INSURANCE COSTS

A mini-survey of insurance companies in Florida revealed no objections to insuring homes with solar energy installations. Solar-equipped homes are covered under standard homeowner policies without special exclusions or rate adjustments. The systems are insured as part of the home, with a premium reflecting the increased replacement cost of the structure. The premium increase is small, usually about $10 to $15 per year or less than 1 percent of the initial system cost.

CHECKLIST FOR LOW INSURANCE RISK SOLAR WATER HEATERS

	YES	NO
1. BUILDING IS STRUCTURALLY SOUND FOR SOLAR SYSTEM. (Is roof capable of supporting collector weight?)	____	____
2. THE SIZE OF THE SOLAR SYSTME IS APPROPRIATE FOR THE BUILDING. (Oversizing is as bad as undersizing.)	____	____
3. COLLECTOR MATERIALS ARE FIRE RESISTANT. (Some types of insulation and gasket materials are not suitable for high temperature applications.)	____	____
4. COLLECTOR MATERIALS ARE DURABLE. (High quality materials should be used to ensure a long working life for the system.)	____	____
5. POTENTIAL DAMAGE FROM LEAKS IN COLLECTOR IS MINIMAL. (Quality control in manufacture is an important element.)	____	____
6. CATCH BASIN FOR ANTIFREEZE LEAKS FROM COLLECTORS PROVIDED (IF APPLICABLE). (Certain transfer fluids may either weaken roofing materials or cause discoloration.)	____	____
7. GROUND-MOUNTED COLLECTORS ARE PROTECTED TO MINIMIZE PERSONAL INJURY. (Injury from metal surfaces or cuts from broken glass can be avoided by proper siting and protection.)	____	____
8. POTENTIAL FOR VANDALISM IS MINIMAL. (It is a poor idea to mount collectors in a high-traffic area.)	____	____
9. DRAINAGE IS PROVIDED NEAR STORAGE TANK. (For protection from undetected leaks, drainage should be provided.)	____	____

10. HAZARDS FOR PERSONAL INJURY AROUND STORAGE TANKS ARE MINIMAL. ____ ____
(Storage containers should be adequately insulated to retain heat and prevent burns. They should not obstruct ingress and egress.)

11. PRESSURE RELIEF DEVICE FOR STORAGE TANK IS PROVIDED. ____ ____
(A pressure relief valve must be included.)

12. UL OR OTHER APPROVED EQUIPMENT IS INSTALLED. ____ ____
(Pumps, etc. should be UL-approved.)

13. ELECTRICAL SYSTEMS WERE INSPECTED OR APPROVED BY A LICENSED OFFICIAL. ____ ____
(In most jurisdictions, 110V wiring and connection to the potable water supply must be done by a licensed contractor and inspected.)

14. EXPOSED PIPES ON DHW SYSTEMS ARE INSULATED AND/OR GUARDED TO MINIMIZE POSSIBILITY OF PERSONAL INJURY. ____ ____
(Adequate insulation will prevent burns and increase system efficiency.)

29. TAX CREDITS

OBJECTIVES: T. 82. Define taxes as money paid by individuals and businesses to local, state or national governments to pay for goods and services.

T. 83. Define government regulations as rules of conduct for consumers and producers.

T. 84. Identify kinds of taxes individuals may be required to pay.

MATERIALS: Student Handout: Taxes and Energy Conservation

ACTIVITIES:

1. Review the concept of taxes as resources paid to the government (local, state, federal) for "services." Then, raise the question of "tax credits" --What are they?

2. Have students call the toll free Internal Revenue Service number for their area--to get information on energy tax credits. They might wish to visit the local IRS office.

   Examine the forms for the two kinds of tax credit: solar applications and energy conservation. Remind students that this is applicable to federal income taxes (not local and state). Have them compute the tax credit on $500 worth of insulation and a $2800 solar water heater for a home.

3. Ask if the added insulation and the solar collector will mean a) added sales tax to be paid this year and/or b) added local taxes on their home (real estate taxes). Assume that the home is assessed for $59,000. Have the students read the student handout: Taxes and Energy Conservation.

4. Show students how state and federal tax policy is used for MORE THAN REVENUE--it is a way to alter customer behavior (or at least to try to do so.).

STUDENT HANDOUT

TAXES AND ENERGY CONSERVATION

Federal Tax Savings

The federal government provides energy income tax credits for both residential and commercial installations as a result of the National Energy Act of 1978 and 1980 amendments to that act. The Internal Revenue Service administers the program and determines equipment eligibility. Specific information on residential credits may be found in IRS Publication 903; information on business credits is in Publication 592. The following are brief descriptions of the three types of credit:

1) Residential Renewable Energy credits (non-refundable) apply to new or retrofit installations made on a principal residence between January 1, 1980, and December 31, 1985. Any credit in excess of liability may be carried forward to succeeding tax years, through 1987. Solar, wind, or geothermal equipment used to provide heating, cooling, hot water, or electricity in a dwelling is eligible. Pool heating, heat pumps, and leased systems do not qualify. The credit amounts to 40 percent of up to $10,000 (a maximum credit of $4,000) invested in qualified active or passive, homebuilt or commercial systems. Passive systems serving a significant structural function are not eligible, with the exception of collectors installed as part of a roof. Table 4 shows the very significant effect of federal income tax credits on solar system costs.

2) Residential Energy Conservation credits (non-refundable) are provided for investments in insulation, caulking, weather stripping, modified flue openings, storm or thermal doors and window, automatic furnace ignition systems, clock thermostats, etc. The credit amounts to 15 percent of the first $2,000 (a maximum credit of $300) invested in qualified equipment between April 20, 1977, and December 31, 1985. Only existing dwellings (those in existence on April 20, 1977) are eligible, and they must serve as the taxpayer's principal residence.

3) Business Energy credits apply to new or retrofit solar or wind energy installations made between January 1, 1980, and December 31, 1985, to provide heating, cooling, hot water, or industrial process heat in a structure. This credit is not available to utilities. Qualified active systems are eligible for a 15 percent tax credit. An additional 10 percent investment credit is available for certain process heating applications, effecting a total 25 percent tax credit.

TABLE 1

Effect of Federal Income Tax Credits on Solar System Costs

System Cost	Federal Tax Credit	Effective Cost
$ 500	$ 200	$ 300
1,000	400	600
1,500	600	900
2,000	800	1,200
3,000	1,200	1,800
5,000	2,000	3,000
10,000	4,000	6,000
20,000	4,000	16,000

Taxpayers whose principal residence is a condominium, cooperative or apartment are eligible for the residential renewable energy credit. If the system is purchased individually, (i.e., independently of a condominium association, tenants association, or one or more neighbors), the taxpayer is eligible for the entire credit. If the system is purchased jointly or through an association, the expenditure must be prorated to each unit and the credit taken on the prorated expenditure.

If a solar system is financed, the interest paid on the loan is deductible from adjusted gross income (IRS Form 1040), which reduces an individual's tax rate and, therefore, reduces the amount of tax paid. Appropriate deductions should be included in any economic cash flow analysis.

State Tax Savings

The state of Florida has enacted two solar tax incentives:

1) Sales Tax Exemption: Solar systems and requisite hardware used for space heating or cooling, domestic hot water, or pool heating and the cost of labor associated with their installation are exempt from the 4 percent state sales tax. "Hardware" includes the piping connecting tank to collector, and the necessary valves, vents, etc. It does not extend to the piping running from the tank to the hot water taps, or piping not used in a solar system. The Florida Department of Revenue has developed an audit form which requires the purchaser to affirm that the merchandise purchased will be used exclusively in a solar system. The law is effective through June 30, 1984. Besides solar systems, other equipment eligible for the sales tax exemption includes waste heat recovery units, heat pump water heaters, air conditioning units with EER values greater that 10.0, and heat pumps with EER greater that 10.0 and COP greater than 2.8.

2) Property Tax Exemption: A 1980 constitutional amendment authorizes a property tax exemption for solar and other "renewable energy" devices (defined to include high efficiency heat pumps, water heater heat pumps, and waste heat recovery units). The law provides three methods for determining the amount of exemption. It must be the lesser of:

1) The assessed value of the property on which the device is installed, less any other authorized exemptions (e.g., $60,000 assessed value of home less $5,000 homestead exemption gives renewable exemption, if less than (2) and (3) below, of $55,000).

2) Original cost of device, including installation, but excluding cost of replacing property removed or improved in the course of installation (e.g., a solar domestic hot water system installed at cost of $2,000; the cost of removing existing hot water tank is an extra $100, but is not included; the renewable exemption, if less than (1) and (3), is $2,000).

3) Eight percent of assessed value of home immediately following installation (e.g., $60,000 house with $2,000 solar system added, increasing assessed value to $62,000. Eight percent of $62,000 equals $4,[illegible], which will be the renewable exemption if less than (1) or (2).

In the example given, the exemption would be $2,000, the installed cost of the system. This will be the most frequent occurrence.

The intent of the legislation was to ensure potential purchasers of solar equipment that the decision to "go solar" would not increase their property taxes. In actual practice, however, few property appraisers have valued the solar system in the property assessment. Presumably, the solar system would have to be included in the assessment before the exemption would be allowed. The new law will no doubt change [illegible] practices by causing solar to be valued and subsequently exempted.

The exemption will be administered through county property appraisers. For an accurate estimate of the exemption's impact on individual tax bills, and information on filing for the exemption, contact your local appraiser's office.

Eligible equipment must be installed between January 1, [illegible], and December 31, 1990, for the exemption to be claimed. [illegible] qualified for the exemption, it will be valid for 10 years.

STUDENT HANDOUT

INSURANCE COSTS

A mini-survey of insurance companies in Florida revealed no objections to insuring homes with solar energy installations. Solar-equipped homes are covered under standard homeowner policies without special exclusions or rate adjustments. The systems are insured as part of the home, with a premium reflecting the increased replacement cost of the structure. The premium increase is small, usually about \$10 to \$15 per year or less than 1 percent of the initial system cost.

CHECKLIST FOR LOW INSURANCE RISK SOLAR WATER HEATERS

	YES	NO
1. BUILDING IS STRUCTURALLY SOUND FOR SOLAR SYSTEM. (Is roof capable of supporting collector weight?)	____	____
2. THE SIZE OF THE SOLAR SYSTME IS APPROPRIATE FOR THE BUILDING. (Oversizing is as bad as undersizing.)	____	____
3. COLLECTOR MATERIALS ARE FIRE RESISTANT. (Some types of insulation and gasket materials are not suitable for high temperature applications.)	____	____
4. COLLECTOR MATERIALS ARE DURABLE. (High quality materials should be used to ensure a long working life for the system.)	____	____
5. POTENTIAL DAMAGE FROM LEAKS IN COLLECTOR IS MINIMAL. (Quality control in manufacture is an important element.)	____	____
6. CATCH BASIN FOR ANTIFREEZE LEAKS FROM COLLECTORS PROVIDED (IF APPLICABLE). (Certain transfer fluids may either weaken roofing materials or cause discoloration.)	____	____
7. GROUND-MOUNTED COLLECTORS ARE PROTECTED TO MINIMIZE PERSONAL INJURY. (Injury from metal surfaces or cuts from broken glass can be avoided by proper siting and protection.)	____	____
8. POTENTIAL FOR VANDALISM IS MINIMAL. (It is a poor idea to mount collectors in a high-traffic area.)	____	____
9. DRAINAGE IS PROVIDED NEAR STORAGE TANK. (For protection from undetected leaks, drainage should be provided.)	____	____

30. GOVERNMENT REGULATION

OBJECTIVES: T. 83. Define government regulations as rules of conduct for consumers and producers.

T. 85. Define regulatory agencies as appointed or elected groups of individuals who are responsible for preparing and administering government regulations.

MATERIALS: Student Handout: Consumer Complaint Form
Sensible Solar System Selection

ACTIVITIES:

1. What is government regulation? Explain the following to students: In the American economy the questions of what to produce, how to produce it, and how to share it are not left exclusively to free market forces. In our mixed economy, government plays a key role. Government influences the allocation of resources in several ways. Control over the production of some goods and services (such as national defense, highways and justice) has been removed from the private sector and placed in the public sector where government makes the important decisions. Government also intervenes in many markets with regulations and controls with the intest to improve upon the results produced by the free play of market forces. Examples are public utility regulation, tariffs, minimum wage laws, and antipollution and safety requirements. Finally, through its taxing and spending activities, government shifts control over resources from private hands to the public, and it also redistributes income among individuals through transfer payments. These activities influence what and how much will be produced, how it will be produced, and how it will be shared or used.

2. Discuss with students what they think the government ought to do in each of the following cases:

   a. Mary and Harry, now retired in Ft. Myers, buy a $15,000 solar water heating system which will last "40 years." They are 70 years old and think that the salesperson mislead them.

   b. Sally and Bill bought a solar pool heater and it never worked properly. They are quite unhappy.

   c. Carl and Tom bought a solar water heater. The plumber left their roof a mess and it now leaks.

   d. ABC Collectors, Inc. told Tom that their collector would provide 95% of his hot water needs. It didn't. He is angry after spending $2,800.00.

3. Have students read the handouts. Is solar collector certification a necessary and proper function for government? Why? Why not?

4. Tell students that the Florida Department of Professional Regulation licenses building contractors and subcontractors. To get a license, a builder must pass a State examine which has solar energy questions on it. Is this a necessary and proper function of government? Why? Why not?

5. The Florida Division of Consumer Services in Tallahassee distributes material and receives complaints about solar energy matters. Read the brochure and the complaint form. Is this a necessary and proper function of government? Why? Why not?

6. Check with your county commission to see what local regulations and regulatory agencies operate in the solar energy field (e.g., building code inspectors' office, consumer protection office, etc.)

7. Design a simplified complaint form that could be used to investigate problems with solar equipment.

How Can I Protect Myself From Unscrupulous Solar Energy Equipment Salesmen and Poor Quality Systems?

In a relatively new and fast-growing field like solar energy, there may be a few dishonest firms. Ask the equipment salesman for a list of customers, and talk to them. Also, check into the firm's reputation. The contract with your installer is very important, because that is the person you will call first in case of trouble. Ask about the warranty offered and read it carefully. It is desirable to have a double warranty, one from the installer and one from the solar manufacturer.

Cost-effectiveness and reliability are prime concerns when buying solar collectors. To aid Floridians in this respect, the Florida Solar Energy Center conducts a state-mandated program of collector testing and certification.

All collectors now sold in the state of Florida should bear the Center's label as shown in Figure One. Three performance ratings are given, and the middle rating, marked "Intermediate Temperature," should be used to compare collectors for domestic water heating. Buy a certified collector supplying the most intermediate temperature Btu per dollar of installed cost. A list of FSEC-certified collectors and their ratings can be obtained free of charge from the FSEC Public Information Office.

In the near future, FSEC will conduct a state-mandated program of standards promulgated for solar domestic hot water and solar swimming pool heating systems. It will be up to the building inspectors and local code officials to enforce these standards and ensure that solar installations meet the FSEC standards. For more information contact the FSEC Standards Office.

SOLAR COLLECTOR CERTIFICATION

FLORIDA SOLAR ENERGY CENTER
300 STATE ROAD 401
CAPE CANAVERAL FL 32920

FSEC 1234
MANUFACTURED BY
Manufacturer's Name
Street Address
City State and Zip Code

MODEL # 5678
SERIAL #

has been tested for thermal performance and meets the minimum standards established by the Florida Solar Energy Center as directed by Section 377 705 Florida Statutes

THERMAL PERFORMANCE RATINGS*

Low Temp (35 C 95 F)	27 790 kJ/day	26 300 Btu/day
▶ Intermediate Temp (50 C 122 F)	18 800 kJ/day	17 800 Btu/day ◀
High Temp (100 C 212 F)	1 300 kJ/day	1 200 Btu/day

*Based on an assumed standard day for Florida

GROSS COLLECTOR AREA 2 688 m^2 (28 93 ft^2)
COVER PLATE AREA 2 704 m^2 (29 10 ft^2)
COLLECTOR LENGTH 2 188 m (7 18 ft)
COLLECTOR WIDTH 1 229 m (4 03 ft)
COLLECTOR WEIGHT 52 3 kg (115 3 lb)
FLUID CAPACITY 7 9 L (2 09 gal)
REC FLOW RATE 1 9 Liquid mL/s (0 5 gpm)
MAX OPERATING PRESSURE 827 kPa gauge (120 psig)
MAX LOAD WIND 1628 Pa (34 psf)
THERMAL PERFORMANCE EFFICIENCY (ASHRAE 93 77 or 96 80)
Y INTERCEPT 56 6
SLOPE 646 $\frac{\text{Watts}}{m^2 \ C}$ $\left(114 \ \frac{\text{Btu}}{ft^2 \ hr \ F}\right)$
INCIDENT ANGLE MODIFIER AXIS 1 0 05 AXIS 2 N/A
USE RESTRICTIONS none

Figure One
THE FSEC COLLECTOR CERTIFICATION LABEL

▶ Use "Intermediate Temperature" rating to compare collectors for domestic water heating applications ◀

SENSIBLE SOLAR SYSTEM SELECTION

If there is one characteristic consumers have in common, it is the desire to get one's money's worth on a commercial transaction. In the solar field, there are four main obstacles in satisfying this all-important objective:

1. The consumer's own lack of knowledge and inexperience in this field.
2. Manufacturers who unintentionally build shoddy products and who are too overenthusiastic about their products.
3. Dealers who unintentionally install the system incorrectly.
4. Deliberate fraud and misrepresentation.

The best weapon against all four is for you to recognize your own limitations and to rely upon competent engineering counsel. Here are some steps you can take to insure that you get your money's worth in a solar system.

** *Ask for proof that the product will perform as advertised.* The proof could come from an independent laboratory or a university. You should have the report itself, not what the manufacturer states the report claims.

** *Examine the warranty carefully.* Remember that according to the law, the manufacturer must state that the warranty is full or limited. If it is limited, know what the limitations are. How long does the warranty last? Are parts, service, and labor covered? Who will provide the service? Does the equipment have to be sent back to the manufacturer for repairs? Make sure you understand the terms of the warranty before you buy. Ask the seller what financial arrangements, such as an escrow account, have been made to honor the warranties.

** *Solar components are like stereo components — some work well together, others don't.* If the system you are purchasing is not sold as a single package by one manufacturer, then you should obtain assurance that the seller has had the professional experience of choosing properly.

** *Ask the man or woman who owns one.* Ask the seller for a list of previous purchasers and their addresses, and then ask the owners about their experiences.

** *Be careful of sellers who use Post Office box numbers.* Though many legitimate businesses use these outlets as a convenient way to receive bills and orders, a common tactic of the fly-by-night artist is to use a Post Office box number, operate a territory until the law starts closing in, then move and take a name in a new territory. *Find out from the seller where his place of business is, how long he has been there, and ask for his financial references.* The installer should be bonded, insured, licensed, and have a building permit.

** *Be sure you will know specifically who will service the solar system if something goes wrong.* Don't settle for a response that any plumber or handyman will do.

** *Don't try a do-it-yourself kit, unless you really have a very solid background as a handyman.* One or two mistakes could make a system inoperable and you will have no one to blame but yourself.

** *Remember that what counts with a solar system is the amount of BTU's delivered for the final end use of the system, and that this amount can fluctuate widely.* A good guide to performance is whether the season is typical or atypical. If it is typical, and your energy use patterns haven't changed, then the savings projections may have been inaccurate.

** *If the seller makes verbal claims that are not reflected in the literature handed out, ask him to write those claims down, and to sign his name to it.* Compare what he said with what he wrote. Save that statement.

** *Beware of simplistic claims.* They generally have a catch. "This solar system will handle up to 90% of your heating needs" may only apply to homes that have extravagant insulation.

CONSUMER COMPLAINT FORM
(Please print or type)

(Date)   (Full name of person filing complaint)

Your Home Address: (street)   Telephone: (area code-number)

(city)   (state)   (zip code)

Your Business Address: (Employed by)   Telephone: (area code-number)

(city)   (state)   (zip code)

I wish to complain about the following company or person: (company name)

Telephone: (area code-number)

Address: (street)   (city)   (state)   (zip code)

Product or service involved:

List all company representatives with whom you have had contact:

Did you complain to the company? ______ When?

DID YOU SIGN ANY PAPERS? ______ DATE?
(IF SO, ATTACH COPIES, OR SEND ORIGINALS FOR US TO COPY AND RETURN TO YOU.)

Have you contacted a private attorney? ______ If so, give his name and his address:

Explain your complaint fully, giving events in the order in which they happened, if possible. (Use additional sheets if necessary.)

(over)

If your complaint relates to false advertising or deceptive trade practices, indicate when and where the product or service was advertised. (If possible, attach a copy of the advertisement.)

What would satisfy your complaint?

Are you under 18 years of age? ____________

May a copy of this complaint be sent to the party complained about? ________

I wish to file this complaint with your office. I understand that your office does not conduct litigation for individuals in matters which involve purely private controversies. I am, however, filing this complaint to notify your office of the activities of this party and for any other assistance you may be able to render.

(Signature of Person Filing Complaint)

RETURN COMPLETED COMPLAINT FORM TO:

Florida Department of Agriculture & Consumer Services
Division of Consumer Services
The Mayo Building
Tallahassee, Florida 32304

31. HOW CAN LAWS AFFECT A DECISION TO INVEST?

OBJECTIVE: T. 87. Name some different kinds of goods and services provided by local, state and national governments.

Students should be able to:

- Identify government actions that encourage (or, if you turn it around, discourage) private business investment. In this lesson students study the effects various governmental actions may have on investment decisions. In a modified market economy investment decisions are based primarily on the anticipation of profits. Government cannot order that investments be made. But there are a number of ways government can encourage private business investment. This lesson is designed to illustrate some of these ways.

- Evaluate some of the costs and benefits of government actions on business ventures.

MATERIALS: Student Handout: "Which Government Action Would Encourage Private Investment? Which Would Not?"

ACTIVITIES:

1. We suggest plunging directly into the lesson by asking the class to respond to these questions:

   a. Why doesn't the government just take on the responsibility for the development and production of energy?

      (Student answers will vary. You might want to point out that in a modified market economy such as the United States, the consumer ultimately determines what is to be produced. Firms respond to consumer demands and try to influence consumer demand through advertising, etc. They then determine how to produce and for whom. However, the government can prohibit certain actions, regulate others, and encourage still others. Only in times of national emergencies may the government take over private businesses, and then only for the length of the emergency.)

   b. Why might the government have different goals for energy development than private business firms?

      (The government may not be as directly interested in profits to be made. It may have the interests of the general public or of special interest groups more in mind than would private businesses).

   c. Is a secure supply of energy for the nation the responsibility of government? On what authority is government based? Explain.

Source: National Science Teachers Association

(All government action must ultimately be based on the Constitution. In the Preamble, the government is given the responsibility for providing for the "common defense," "insuring the blessings of liberty for ourselves and our posterity," and "providing for the general welfare." These stipulations, plus the interstate commerce clause, give government the power to do for people what they cannot do for themselves.). Ask: Why might government be concerned about having adequate energy for our needs? What are the consequences of an energy shortage? And ask:. Are there different philosophies on the role of government in the U.S. economy? Discuss.

Distribute copies of the handout, "Which Government Action Would Encourage Private Investment? Which Would Not?" Have students check the appropriate column. After they have finished marking their choices, discuss their answers. The following paragraphs may serve to help guide the discussion:

A. With a tax credit, a firm or individual determines the amount of taxes owed the government, and then deducts a prescribed amount, called a tax credit. At present, 40 percent of the first $10,000 spent on solar equipment for a maximum of $4,000 can be deducted from the income tax. While tax credits benefit people who install solar heating, other taxes may have to be raised to make up for the tax loss. In effect, a redistribution of money takes place. Would X

B. Unless it can expect to make a profit in the long run, a firm will not invest its money. If, for example, the price of fossil energy is kept low, the cost of producing energy from new or marginal energy sources will probably far exceed any expected profits to be made for a long time to come. Firms will be unlikely to invest in new energy production under such circumstances. Gas companies have long argued that allowing the price of gas to adjust to supply-demand equilibrium prices will induce companies to produce more gas. An increase in the price of energy, while it may increase supply, usually also means that the consumer must pay more. Would Not X

C. A tax on profits can have a negative effect on the decision to invest in energy. The difficulty for government in taxing profits is to determine the difference between excess or windfall profits and profits necessary to encourage investment. Government taxing policies must not be a disincentive to investment. Would Not X

D. If the government leases its land to the energy industries at a low price, investment is encouraged. A low lease price, however, reduces potential government income. Some argue that this is an unfair or unnecessary "gift" to the firms. However, without a low price, firms may not bid for the land and the energy may remain undeveloped. Development of energy sources on government land may compete with the use of this land for recreational or environmental protection purposes. Would X

E. Banks make loans only if they expect to get paid back. Some energy development operations are high risk enterprises. Banks have been reluctant to make loans or have done so only at high interest rates, but government guarantee might induce banks to make capital available for

energy development at a lower cost. If the banks divert their limited capital to energy investments, however, a scarcity of capital for other investment needs may occur. Would X

F. There is little profit in the early stages of research and development. By supporting experimental and prototype work, the government can encourage the growth of new technologies and industries. Businesses and universities bid for government contracts. However, any increase in government expenditure can result in increased taxes for all. Will Not Have X

G. (Note: This is a complex issue with several possible "right" answers. Some of the points that should be brought up in a class discussion on this subject follow; students might have other ideas to discuss.).

Deregulation could create an open, competitive market, causing prices to fall and quantity to rise. But, when dealing with a limited resource such as energy, prices would not fall and would in fact continue to rise. This would, however, stimulate short-term investment as profits would be high.

If oil and natural gas prices were deregulated (causing their prices to rise), investment in conservation and alternative energy sources--solar, wind, and hydro power, biofuels, synfuels, etc.--would be stimulated because they would then become economically feasible.

However, others argue that prices could become so high that consumers might not have the capital available or the borrowing capacity to invest in alternatives. Thus, they would be trapped in a vicious cycle--their fuel bills so high they can't make the investments in alternatives so the bills will be lower--but if they don't invest, next year's bills will be even higher. It may make more and more people feel like they can never make ends meet. Would X (debatable)

STUDENT HANDOUT

WHICH GOVERNMENT ACTION WOULD ENCOURAGE PRIVATE INVESTMENT? WHICH WOULD NOT?

Check one (X)

Would	Would Not		
_____	_____	1.	Grant tax credits, whereby the amount of taxes owed is lowered.
_____	_____	2.	Regulate the price of energy at a level industry considers too low to make a profit.
_____	_____	3.	Place a high tax on profits.
_____	_____	4.	Make government-owned land available to industries. (Surveys indicate that 50% of the coal, 75% of the shale oil, 40% of the uranium, and 60% of the geothermal energy supplies in America are on government land.)
_____	_____	5.	Guarantee loans for businesses making energy investments.
_____	_____	6.	Pay for research and development in new energy technology.
_____	_____	7.	Allow the market forces of supply and demand to determine energy prices.

APPENDIX 1.

FREE ENTERPRISE AND CONSUMER EDUCATION OBJECTIVES

TOPIC	OBJECTIVES - The student will:
#A - FREE ENTERPRISE, BUSINESS ORGANIZATIONS, AND PRIVATE PROPERTY	1. Distinguish between private and public property.
	2. Identify private property as the basic foundation of a free enterprise system.
	3. Define a free enterprise (capitalist) economy as a system where individuals and businesses risk their own investment in competition with other individuals and businesses (managers) to produce and distribute goods and services for profit.
	4. Identify elements of the American economic system to include: freedom, opportunity, justice, efficiency, growth, and security.
	5. Define competition as the effort of two or more parties to secure the business of a third party.
	6. Describe some ways in which competition benefits the consumer.
	7. Identify sole proprietorship, partnership, cooperatives, and corporation as four types of business organizations (in the private sector).
#B - TRADITION, COMMAND, AND MARKET ECONOMIC SYSTEMS	8. Identify the categories of economic systems: tradition, command, and market.
	9. Name the three questions that all economic systems must try to answer: what is to be produced? and to whom will it be distributed?

#C - LABOR ORGANIZATIONS

10. Define labor force as people employed or seeking employment.

11. Define labor union as an association of workers who are organized to bargain collectively with employers.

#D - SCARCITY AND PRODUCTION

12. Define consumer goods as items that are capable of satisfying a human want.

13. Define services as work done for others which does not produce goods.

14. Identify why scarcity requires choices.

15. Identify energy resources.

16. Define producer as a maker of goods or a performer of services.

17. Define production as the creation of goods or services.

18. Distinguish between producers of goods and performers of services.

19. Identify how substitutions can be used when a resource becomes more scarce.

20. Distinguish between a consumer good and a capital good.

21. Identify the factors of production as natural resources, labor, capital, and management.

22. Identify how energy factors affect the cost and availability of goods and services.

23. Identify how environmental factors affect the cost and availability of goods and services.

#E - CAPITAL INVESTMENT, PROFIT MOTIVE, AND ECONOMIC GROWTH

24. Define capital goods as tools, equipment, machinery and buildings that are used in the production of other goods and services.
25. Define profit as the reward for taking risk in business.
26. Define net profit as remainder after all costs, expenses, and taxes are satisfied.
27. Identify some ways in which firms use profits.
28. Define economic growth as an increase in a nation's total output of goods and services.

#F - SPECIALIZATION, TECHNOLOGY, EXCHANGE AND INTERDEPENDENCE

29. Name some methods of economic exchange.
30. Define specialization as individuals or groups concentrating on one job rather than attempting to do many jobs.
31. Define exchange as obtaining goods and services from others in return for money, credit or other goods and services.
32. Define technology as the use of tools and/or knowledge to produce goods and services.
33. Identify how technological progress might result in lower prices, increased productivity and a better quality product.

#G - SUPPLY AND DEMAND

34. Define demand as the amount of goods and services that buyers are willing to buy.
35. Define marketplace as a setting where goods and services are bought, sold, or traded.
36. Define supply as the amount of goods or services that sellers are willing to sell.

37. Name some factors which may influence the supply of a good or service.

38. Name some factors which may influence the demand for a good or service.

39. Define demand as the amount of goods and services that buyers are willing to buy at each specific price in a given market at a given time.

40. Define market as a situation in which individuals and businesses interact to buy, sell or exchange goods and services.

41. Define supply as the various amounts of goods and services that sellers are willing to sell at each specific price in a given market at a given time.

42. Define The Law of Supply and Demand as follows: as the price of a good or service increases, sellers will offer more and buyers will demand less; as price falls, sellers will offer less and buyers will demand more.

#H - PRICE, MARKET EQUILIBRIUM, AND INFLATION

43. Define price as the money value set for a good or service.

44. Define inflation as a decrease in the purchasing power of money.

#I - ADVERTISING AND MARKET RESEARCH

45. Define advertising as a means to inform people about a firm's products or services, or to persuade people to purchase a firm's goods or services rather than those produced by a competitor.

46. Recognize misleading and non-misleading advertising.

#J - DISTRIBUTION	47. Identify the different methods of transportation used to distribute goods and services.
	48. Define distribution as the process for getting products from producers to consumers.
#K - SCARCITY AND CONSUMER DECISION-MAKING	49. Define consumers as users of goods and services.
	50. Define consumption as the use of goods and services.
	51. Identify some benefits of comparison shopping.
	52. Identify how a consumer choice involves the giving up of other alternatives.
	53. Define impulse buying.
	54. Define planned buying.
#L - PERSONAL AND FAMILY INCOME AND BUDGETS	55. Identify some sources of income.
	56. Define budget as a plan for the use of money, time and other resources.
	57. Distinguish between total pay and "take home" pay.
	58. Identify who must file and pay an income tax.
	59. Demonstrate the completion of a simple income tax return.
#M - SAVINGS AND PERSONAL INVESTMENTS	60. Define savings as income which is not spent for consumer goods or services but is set aside for future use.
	61. Name reasons why people save.
	62. Define personal investment as the purchase of an asset (with some degree of risk) for the purpose of earning future income.

#N - FINANCIAL INSTITUTIONS, CONSUMER CREDIT, AND INTEREST RATES	63. Define credit as a promise to pay in the future for goods, services or money received now.
	64. Compare saving with a financial institution to saving at home.
	65. Define interest as money paid for the use of money.
	66. List some advantages of using credit.
	67. List some disadvantages of using credit.
	68. Identify some credit plans and sources that may be used for consumer purchases.
	69. Identify the importance of credit ratings and their effect on the consumer.
	70. Classify financial institutions, such as banks, savings and loan, and other credit institutions, according to the services they provide.
#O - SELECTION, USE, AND CARE OF GOODS AND SERVICES	71. Identify factors to be considered when selecting a consumer good or service.
	72. State reasons why a higher price does not necessarily indicate better quality.
#P - CONTRACTS, WARRANTIES, AND GUARANTEES	73. Name some of the basic provisions contained in warranties and guarantees.
#Q - CONSUMERS EDUCATION, RIGHTS, AND RESPONSIBILITIES	74. Identify some benefits of consumer education to the consumer.
	75. Identify rights and responsibilities of consumers while interacting with providers of goods and services.

#R - CONSUMER LEGISLATION, REGULATION, AND SERVICES	76.	Names some consumer protection agencies, institutions, or organizations (public or private) that provide sources of information and deal with specific consumer problems.
	77.	Identify some advantages of consumer protection laws to consumers.
	78.	Identify some disadvantages of consumer protection laws to consumers.
#S - INSURANCE	79.	Define insurance as the purchase of protection against loss.
	80.	State the principle that premiums which purchase insurance are based primarily on the degree of risk.
	81.	Identify areas of protection covered by various types of personal insurance, such as automobile, health, life and home or property ownership.
#T - GOVERNMENT FUNCTIONS (TAXATION, SPENDING, AND REGULATION)	82.	Define taxes as money paid by individuals and businesses to local, state or national governments to pay for goods and services.
	83.	Define government regulations as rules of conduct for consumers and producers.
	84.	Identify kinds of taxes individuals may be required to pay.
	85.	Define regulatory agencies as appointed or elected groups of individuals who are responsible for preparing and administering government regulations.
	86.	Identify the sources of government finance to include: taxes, borrowing, increasing money supply, fees and other service charges.

87. Name some different kinds of goods and services provided by local, state and national governments.

#U - FEDERAL RESERVE SYSTEM AND ROLE OF MONEY

88. Identify how money serves as a medium of exchange.

#V - INTERNATIONAL TRADE AND MONETARY EXCHANGE

89. Identify ways in which economic conditions in one country are influenced by economic conditions in other countries.

Solar Energy in Florida
present and future prospects

by Gerard G. Ventre and Subrato Chandra
FSEC-EN-1-82 March 1982

Why Solar ?

Florida, the "Sunshine State," has abundant solar energy and a significant population to utilize it. The only region of the U S. that has more sunshine is the desert southwest, which is much less populated and, consequently, has much less demand for energy.

Florida does not have significant fossil fuel resources and is located far from the coal producing states. Ninety percent of Florida's energy is derived from fossil fuels and almost all of its energy is imported.

Fossil fuels are becoming scarce; world oil production will most likely peak between 1985 and 2000 U.S. oil production peaked in 1970.

Fossil fuels have environmental problems —not only the build-up of various pollutants, but also the large-scale production of carbon dioxide, which may seriously affect the world's climate

Florida's economy is vulnerable to fossil fuel supply interruptions, and it therefore behooves us to develop our valuable energy resource—sunshine

Benefits of Solar

Solar is a renewable, clean energy that is in abundant supply

Devices powered by solar energy can save you money, help conserve our nation's depleteable resources, and reduce our dependence upon imported oil.

Unlike petroleum, the price and availability of solar energy are not subject to manipulations by other nations.

A healthy solar industry will aid in Florida's industrial development.

Solar applications are labor-intensive and will create jobs.

Solar energy represents a decentralized power source that adapts to a variety of appropriate applications, ranging from heating water to generating electricity.

Solar energy has strong public appeal.

Sunshine is the most important reason for Florida's healthy tourist industry.

The sun is the source of all life on earth.

Solar Water Heating

Water heating represents the state's oldest use of solar energy; South Florida has had solar water heaters since 1900 It is estimated that about 30,000 to 50,000 units were installed by 1950, but about that time their popularity began to decline due to readily available cheap energy from fossil fuels.

Solar water heaters are simple, commercially available, and economically competitive with electric water heaters.

Water heating accounts for about 25 percent of residential energy use in Florida, or roughly six percent of Florida's total energy use.

Solar systems presently cost between \$1,000-\$3,000 (about \$2,000 average statewide) for a family of four and may save as much as \$225-\$300/year in electric bills. They cost \$500-\$1,000 for do-it-yourselfers.

Because they are material-intensive, the prices of solar water heaters are not expected to come down as they did for electronic calculators. Consequently, the sooner a person buys a solar water heater, the sooner he begins to save.

Federal income tax credits of 40 percent of the system cost are available. For a \$2,000 solar water heater, the cost to the consumer is only \$1,200.

Florida now exempts solar systems from property tax and sales tax.

There have been more solar water heaters installed in Florida than in any other state except California, which has a much larger population. On a per capita basis, Florida leads California in the number of installations

Projections/Goals: "2 million by 2000!"

	Estimated No. of Units 1985	2000
Florida (hot water only)	300,000	2,000,000
U.S. (includes space heating)	2,500,000	—
California (includes space heating)	1,500,000	—

The quality of flat-plate solar collectors has improved dramatically over the past decade, both in performance and workmanship.

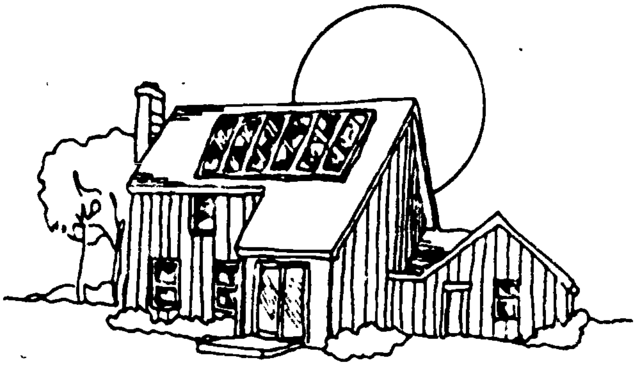
All solar water heaters manufactured or sold in Florida must meet standards developed by the Florida Solar Energy Center

Solar Pool Heating

Solar pool heating is not only currently available, it also is the most economically attractive solar technology

A large market potential exists in Florida, due to the great number of pools and the steadily growing population to enjoy them.

Individual savings by substituting solar heat for fossil fuels in heating a swimming pool are significant



Pool heating is a major solar industry The square footage production of low-temperature pool collectors has exceeded that of all other kinds combined (primarily because considerably larger collector areas are required for pool heating).

Typical residential costs are about $? 600-$3,200 for commercially built and installed solar po.. neaters. They typically extend the swimming season three to four months beyond the normal season in Florida.

All solar pool heaters manufactured or sold in Florida must meet standards developed by the Florida Solar Energy Center

Solar Space Heating and Cooling

Space heating accounts for only about 9-10 percent of residential energy use in Florida due to our warm climate

Therefore, active space heating systems are economically unattractive in most of Florida Exceptions Do-it yourself systems may be economical in northern Florida.

Space cooling accounts for about 33 percent of residential energy use in Florida.

It behooves us to develop solar cooling because the sun shines most brightly (i e , the solar resource is most available) when the air conditioning is most needed.

However, solar thermal cooling (absorption, Rankine, or desiccant cycles) is economically unattractive today. Present cost is about $30,000 installed for a typical residential absorption system Future prospects may improve if significant cost-reducing breakthroughs are made Commercial applications appear more promising.

Solar cooling by photovoltaic cells generating electricity and driving conventional air conditioners may become attractive in the future if photovoltaic prices come down as projected.

Passive solar and low-energy building design techniques that work well in a hot, humid climate such as Florida's need to be developed (The word "passive" implies natural use of the solar environment to achieve the comfort levels desired. Very little or no mechanical equipment is required with passive designs.)

Passive cooling in Florida involves a combination of heat gain prevention techniques, heat rejection strategies, and the proper use of heat storing materials in the building design

Solar Cells/Photovoltaics

Photovoltaic or solar cells are very attractive, as they generate electricity directly from the sun without any moving parts or noise. Therefore, many energy end-uses can be provided, ranging from household lighting to utility electricity generation.

Their technical feasibility/reliability has been proven through the space program's use of cells to power satellites.

The major barrier is cost At present, photovoltaics are competitive only in remote applications such as water pumping for irrigation, communications relay stations, cathodic (corrosion) protection of bridges, etc.

Unlike solar thermal collectors (like those used for water heating), large reductions in cell costs are expected in the future. Department of Energy R&D already has reduced cell costs from $200/peak watt to $7 $15/peak watt. A major DOE R&D effort is under way

1986 cost projections by DOE for residential applications (in 1980 dollars):

Array Cost ($/peak watt)	**$0.70**
System Cost ($/peak watt)	**$1.60**
Equivalent electricity cost in Florida	**7¢/kwh**

NOTE: Peak watts refer to electric power produced when the sun is brightest.

The national goal is to have 500 MW of photovoltaic electric generating capacity by 1990.

The two major areas of photovoltaic research at the Florida Solar Energy Center are 1) utility interactive residential systems, and 2) stand alone systems for remote applications

Energy from Biomass

Biomass resources include all organic matter except the fossil fuels.

Examples of biomass resources include urban refuse, manure, logging and wood production, forestry residues, crop residues, industrial wastes, municipal sewage sludge, special energy crops, and aquatic energy farms

Biomass energy conversion techniques include direct combustion, thermo-chemical gasification and liquefaction, anaerobic digestion for methane production, sugar fermentation to produce alcohol, and hydrogen production.

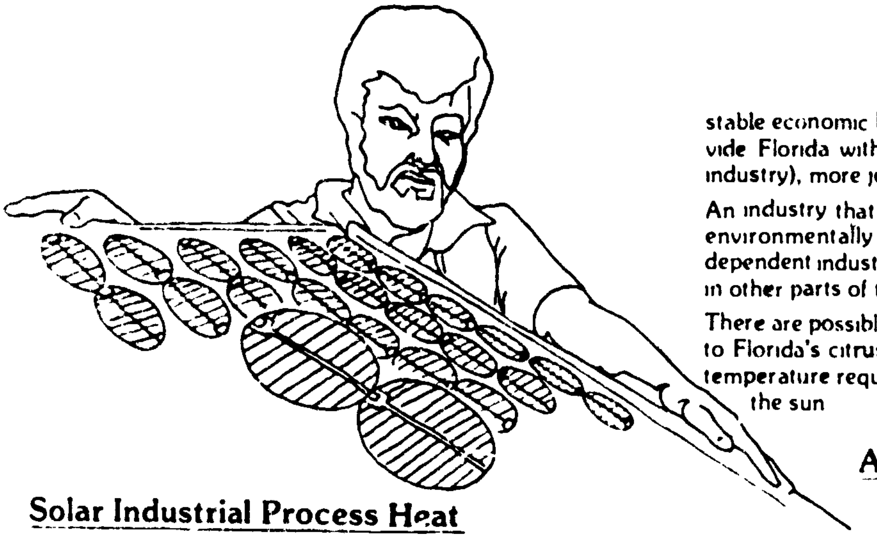
There is a relative abundance of usable land in the U S , particularly in Florida

Environmentally, organic wastes are typically low in sulfur, and the production of ash in combustion is much less a problem than with coal. Nitrous oxides will be produced, as always, when combustion occurs in air.

Water hyacinths can be used to generate methane gas This process currently is not cost effective, but when it becomes so it will also help free Florida's waterways for both navigation and recreation.

Biomass fuels (or biofuels) presently contribute approximately one to two percent of our (U S) energy needs, mostly as direct combustion of wood.

Because of climate and terrain, Florida is exceptionally well suited to develop biomass resources. The combination of rainfall and long growing seasons, which allows for multi-crop production, makes Florida a leader in terms of biomass resource potential.



Solar Industrial Process Heat

The industrial sector is the largest user of energy in the U.S., accounting for approximately 37 percent of the total national energy consumption. However, only 18 percent of Florida's total energy use is for industry

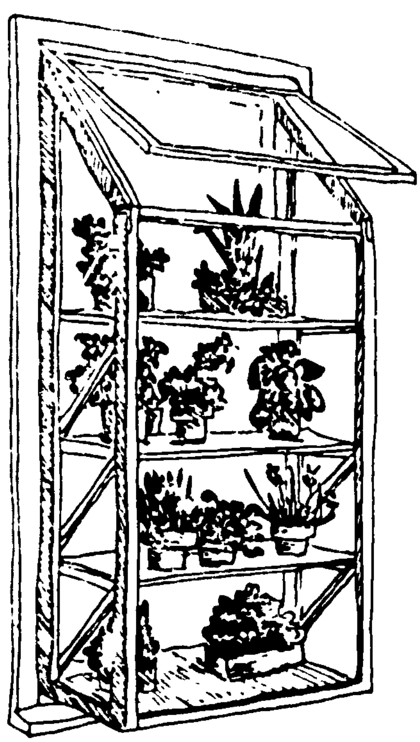
Production of process heat and steam accounts for approximately two thirds of the total energy used by industry

There is significant potential for the use of solar energy to provide process heat and steam and, therefore, to make a significant contribution to the nation's energy needs.

Not only is Florida in an extremely vulnerable position in terms of available fossil fuels, its economy is heavily dependent upon tourism, which could be severely affected by liquid fuel shortages These same fuel shortages could accelerate the migration of Northerners to the attractive warmer climates of Florida. Consequently, there would be a need for both jobs and a more stable economic base. Solar industrial process heat could provide Florida with more manufacturing capability (i e , more industry), more jobs, and a stronger economy.

An industry that is partially fueled by solar energy would be environmentally more acceptable than the heavily fossil-dependent industries that have developed over the last century in other parts of the country.

There are possible applications of solar industrial process heat to Florida's citrus and paper industries, whose relatively low temperature requirements could easily be met by energy from the sun



Agricultural Applications

Agriculture is the world's greatest user of solar energy for human needs, with about 11 percent of the land area under permanent crops.

Agricultural applications of solar energy include heating and cooling of greenhouses, food processing, grain drying, crop drying, and heating of livestock shelters.

The temperatures required for many agricultural processes are relatively low.

The basic technology already exists for collecting the required heat from the sun

Most agricultural applications have intermittent heat requirements (i e , the requirements vary with the weather and the planting, growing, and harvesting seasons). Because of limited seasonal use, the solar systems must be set low in cost to be economically attractive.

Presently, the major agricultural application of solar energy in Florida has been for greenhouse heating

Like other applications, solar energy for agriculture will become more attractive as the cost of conventional fuels continues to escalate

Other Solar Applications

There are other solar technologies and applications that either are not particularly suited for Florida or will not be available until well into the future. These technologies include wind power, solar thermal electric conversion, ocean thermal energy conversion, and solar power satellites.

Wind power systems will become increasingly attractive in those locations of the country where the amount and quality of the wind energy make them economically viable The potential for wind generated electricity is significant on a national scale, but there is limited potential in Florida, mainly along the coastline or possibly offshore

Solar thermal electric conversion technologies can be categorized as central receiver plants, distributed collector systems, or total energy systems Most of these systems use high temperature concentrating collectors which must track the sun (and are consequently quite expensive) Because of their dependence on a large ratio of direct sunlight to diffuse sunlight, these systems at present do not appear particularly attractive for Florida.

Ocean thermal energy conversion (OTEC) could derive significant energy from the Gulf of Mexico, off the Keys, and in the Florida Straits, however, serious technological and economic problems must be alleviated if this futuristic alternative is ever to become a significant supplier of our nation's energy

Solar power satellites (SPS) possess features which are particularly attractive for longer term energy supply The interface of this program with NASA Kennedy Space Center activities is of special interest to Floridians Although the size (on the order of 25 to 50 square miles per satellite), cost and complexities of this program are enormous, its contributions beyond the year 2000 could be very significant

Conclusions

Although the contribution of solar water and pool heaters in displacing fossil fuels is small, the application of these technologies should be strongly pursued for the following reasons

- —They represent a Florida industry which encompasses approximately 75 manufacturers and 300 vendors.
- —The installation of solar equipment is labor-intensive.
- —The manufacturing of solar equipment is a new and environmentally clean industry.
- —Domestic water and pool heating (and some agricultural uses) are presently the only cost effective solar technologies which are applicable to Florida's energy needs.
- —The success of these near term technologies should influence the rate and manner in which other solar technologies are introduced.
- —The public awareness and acceptance of near term solar technologies may have a positive influence on the public's attitudes and practices concerning energy conservation. A solar water heater allows direct citizen contact with and utilization of energy-conserving equipment while providing a needed commodity (hot water) and immediate savings on monthly energy bills.
- —The development of widespread solar industry involves the solution of a variety of institutional problems that will pave the way for a more rapid introduction of the future solar technologies (i.e , problems and conflicts associated with financing and inspecting systems, regulating the industry, and protecting the consumer)

In 1980, the U S spent over $80 billion on oil imports alone The 1982 federal budget for solar development was less than $300 million dollars.

Florida (which has a large and rapidly growing population and is heavily dependent upon energy-intensive tourism) is blessed with abundant sunshine Florida should vigorously pursue the development of solar energy technologies offering the greatest benefits to Floridians. Those to which we should make our most serious commitment include·

1. Domestic water and pool heating
2. Passive solar and low energy building design.
3. Photovoltaics (including photovoltaic cooling)
4. Energy from biomass.

In the longer term, ocean thermal energy conversion and other solar technologies may be important to Floridians

Current Uses of Energy by Sector in Florida and the U.S.

SECTOR	FLORIDA	U.S.
Transportation	36%	25%
Residential/Commercial	38%	38%
Industrial	18%	37%
Governmental and other non-energy end uses.	8%	—

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